

**GENETIC ANALYSIS ON SEED DORMANCY IN
GROUNDNUT (*Arachis hypogaea* L.)**

**Thesis submitted to the
University of Agricultural Sciences, Dharwad
In partial fulfillment of the requirements for the
Degree of**

MASTER OF SCIENCE (AGRICULTURE)

IN

GENETICS AND PLANT BREEDING

BY

YALLAPPAGOUDA B. NAGANAGOUDAR

**DEPARTMENT OF GENETICS AND PLANT BREEDING
COLLEGE OF AGRICULTURE, DHARWAD
UNIVERSITY OF AGRICULTURAL SCIENCES,
DHARWAD- 580 005**

AUGUST, 2011

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1. INTRODUCTION

The cultivated groundnut (*Arachis hypogaea* L.), known to be one of the most important oilseed crops of the world and it has a distinct position among the oil seed crops grown in India. Currently, groundnut is grown on nearly 23.38 million ha around the world with an annual production of 34.85 million tons of nuts-in-shell. The major producers are China, India and the USA which together account for two-thirds of the world output. Developing countries, account for 82 per cent of total groundnut area and 79 per cent of production of the world. Among the developing countries, production is mainly concentrated in Asia and Africa with Asia accounting for 51 per cent of global area and 60 per cent of production. India occupies 30 per cent of global area (6.22 million ha) and contributes 26.8 per cent (7.35 million tons) of total groundnut production (Anon., 2009b). The vegetable oil economy of India depends mainly on groundnut. Groundnut occupies 31.30 per cent of the total cropped area under oilseeds and accounts for 36.10 per cent of the total oilseed production. Karnataka is one of the five major groundnut growing states in the country with an area of 0.91 m ha and production of 0.73 m tonnes (Anon., 2009a). Though India stands first in the production all over the world, the average productivity is hovering around 900 kg/ha as against the average of 2,995 kg/ha realized in USA. Many reasons are ascribed to the low productivity situation in India, among which drought, disease, pest incidence and loss of pods in the field by *in situ* germination takes away major share.

In Karnataka, non dormant bunch cultivars are grown extensively, especially in areas with well distributed rainfall, as they are of short duration and can be harvested with ease. Because of lack of dormancy, when the crop is caught in rains at harvest, the seeds show *in situ* germination. The incidence of *in situ* germination is known to cause about 20-50 per cent loss in pod yield (Varman and Raveendran, 1991) and gets aggravated with the incidence of disease like leaf spot rust and *Sclerotium*. The risk or heavy loss due to *in situ* germination is high in transitional tract of Karnataka because of bimodal distribution of rainfall, wherein, the second peak of rainfall always coincides with harvesting period of this crop.

There are two subspecies in the cultivated groundnut, viz., *Arachis hypogaea* spp. *fastigiata* and *Arachis hypogaea* spp. *hypogaea*. These two subspecies differ significantly in their seed dormancy after maturity. The cultivars of subspecies *hypogaea*, the *Virginia* type, are of long duration and possess seed dormancy for long periods after maturity. While those of *fastigiata*, the Spanish and Valenica types, are generally characterized by a short life cycle and non-dormant (Krapovickas, 1968). The longer periods of dormancy in the Virginia type do not allow immediate use of harvested seeds from one season for sowing in the next or for germination and other tests of seed quality. Therefore, a dormancy period of two to three weeks in erect bunch cultivars of groundnut is desirable.

Although, there are methods available to induce as well as to break the seed dormancy chemically in groundnut, the difficulties associated with these techniques such as high cost involved, non-availability of chemicals and the need for expertise of treatment make breeding dormant bunch varieties a more feasible strategy. But all the identified dormant cultures have been found not suitable for direct use on account of long duration, low productivity, poor adaptability and undesirable pod characters. Thus, incorporation of two to three weeks of dormancy in the ruling erect bunch cultivars through hybridization becomes essential. Many efforts in this direction are concentrated on inter-specific crosses involving Virginia runner types as donors. Although these cultures are good sources of dormancy, they can not be used directly to incorporate dormancy into Spanish and Valenica types because of low recovery of erect bunch segregants and extremely rare occurrence of such segregants combining dormancy (Wadia *et al.*, 1987).

This forces one to search for source of dormancy from among the Spanish/Valencia cultivars. It is essential to identify the dormant bunch cultivars available in the germplasm collection and to quantify the period of dormancy and also to assess their yield potential along with pod and kernel characteristics of economic importance, so that they can be used conveniently as sources of dormancy in breeding programmes.

Dormancy can be controlled by the embryo or can be imposed by extra embryonic tissues, which are of different genetic constitutions. Therefore, the prospect of discovering straight forward Mendelian inheritance of dormancy is slight (Bewly and Black, 1985, Garbutt *et al.*, 1986). In case of groundnut, the unpredictable legume the complexity is further intensified by non-synchronous pod formation followed by differential pod maturity and high environmental sensitivity of the dormancy character. In planning genetic studies it is important to identify the tissue associated with dormancy, in each of the dormant culture. Until the genetics of dormancy is worked out there is no other way for the plant breeder except going for selection from segregating populations. Therefore, generation of information about response of dormancy to selection becomes essential. Apart from assessing germination behaviour of dormant cultures over seasons, it is also necessary for any breeding programme to identify the best recombinants for yield and other economic characters like pod and kernel features for simultaneous improvement.

Keeping all these points in view, the present investigation was planned with the following objectives.

1. To study the genetic variability of seed dormancy in RIL population of TAG 24 x GPBD 4
2. To identify the dormant recombinant inbred lines with other economic traits
3. To assess nature, intensity and duration of dormancy in dormant lines identified in mapping population.

2. REVIEW OF LITERATURE

Dormancy in the early-maturing groundnut cultivars has been recognized as a desirable character (John *et al.*, 1948; Ramachandran *et al.*, 1967; Muhammad and Dorairaj, 1968 and Gautreau, 1984). Efforts have been made towards evolving early maturing bunch cultivars with optimum period of dormancy in groundnut. An attempt has been made to gather all the relevant information on various aspects of dormancy in groundnut and presented in this chapter under appropriate titles.

2.1 Dormancy and its significance

Dormancy is a natural evolutionary consequence. It is a device for optimising the distribution of germination in time and space and its importance is therefore of ecological significance. Dormancy is often assumed to be important in relation to the prevention of vivipary and precocious germination and may also regulate geographical distribution of species (Bewly and Black, 1985).

The failure of the fully mature and viable seed to germinate to an appreciable degree under favourable environmental conditions is referred to as dormancy (Seshu and Sorrells, 1986).

Most of the popular Spanish bunch groundnut varieties lack dormancy due to which they show *in situ* germination when the matured crop is caught in rains resulting in loss in pod yield to an extent of 20-50 per cent (Anon., 1978; Varman and Raveendran, 1991). It is, therefore, desirable to incorporate dormancy of about 2-3 weeks so that the crop overcomes the problem of losses due to *in situ* germination on one hand and yet be available for immediate sowing on the other (Ashok Kumar, 1989; Hemanth, 1990 and Patil *et al.*, 1991).

2.2 Nature of dormancy

In a broad we have view to distinguish, *viz.* (1) Innate dormancy, where the seeds will not germinate even under favourable conditions and (2) Imposed dormancy where the seeds will not germinate when the conditions are unfavorable. Several forms of innate dormancy have been recognized. Seeds may fail to germinate because of impermeable seed coat to water or there is an unsatisfactory after-ripening requirement in storage (Matthews, 1976).

When we consider dormancy mechanism, there are basically two types (a) Embryo dormancy, where the control of dormancy resides within the embryo itself and (b) Seed coat dormancy, in which dormancy is due to structures enclosing the embryo, *i.e.*, the seed coat (Bewly and Black, 1985).

2.2.1 Embryo dormancy

The failure of the viable and mature embryo to germinate under favourable conditions even when it is isolated from seed coat or dispersal unit in dormant seeds is referred to as 'embryo dormancy'.

Viathialingam and Rao (1973a) demonstrated in groundnut with ample evidence that in some cases dormancy resides in the embryo.

Sometimes the maturity or physiological state of the embryo is a cause for dormancy and seeds with immature embryos fail to germinate. Toole *et al.* (1964) observed a long dormancy period in immature seeds of groundnut which declined as maturity advanced. On the contrary, Patil (1967) studied the germination on excised embryos and intact seeds of groundnut pods harvested at 30, 40 and 60 days after flowering and reported that excised embryos had very high percentage of germination as compared to intact seeds and thus it was concluded that, the mechanism under embryo dormancy may involve cotyledons and germination inhibitors in the embryo. There is a good evidence that in many cases the cotyledons are responsible for inhibiting the growth of the axis in dormant embryos (Bewly and Black, 1985). In case of dormant groundnut seeds, germination was improved by excising portions of the cotyledons (Toole *et al.*, 1964).

In groundnut, the application of extracts from different parts of seeds of dormant variety, TMV 1 to seeds of nondormant variety TMV 2, decreased the germination, shoot and root growth. The concentration of inhibitors was higher in the extracts from the embryo region than in those from the seed coat (Viathialingam and Rao, 1973a). In some cases the embryonic axis of non-dormant seeds of groundnut actively produced ethylene gas during germination while dormant seeds produced very low levels of ethylene (Ketring and Morgan, 1971). Higher concentrations of hydroxy proline was specific in the seeds of dormant cultivar TMV 1. In the non-dormant variety TMV 2, one conspicuous feature was the absence of hydroxyproline both in primary axis and cotyledons whereas, it was too high in the primary axis than in the cotyledons of dormant variety TMV 1 (Viathialingam and Rao, 1973b). Ashok Kumar (1989) has reported that the cultures, viz., ICGS-30, ICG-11495 have embryo controlled dormancy.

Venu *et al.* (1995) observed that the period of whole seed dormancy was more in both Spanish and Virginia as compared to embryo dormancy. It was also revealed that the fresh seeds of Dh-3-30 exhibited dormancy period of 20-30 days, whereas in embryos absolutely there was no dormancy.

Bandyopadhyay *et al.* (1999) suggested that dormancy in groundnut is regulated mainly by testa (maternal tissue) in the Spanish type. But by cotyledons and embryonic axis (both zygotic tissue) as well as testa in Virginia type. Thus the genetic control of seed dormancy in groundnut appears to be quantitative in nature.

Breakdown of the endosperm cap over the tip of the radicle is correlated with the production of GA (Groot and Karssen, 1987) and with activities of various enzymes (Toorop *et al.*, 2000) and genes responsible for the various aspects of endosperm cap weakening are being determined (Mella *et al.*, 2004).

2.2.2 Seed coat dormancy

Bewley and Black (1985) stated that seed coat imposed dormancy may be due to (1) interference with water uptake, (2) interference with gaseous exchange, (3) presence of inhibitors in the coat, (4) prevention of the escape of inhibitors and (5) mechanical restraint.

In leguminous crops, seed coat characters were found to be responsible for imposing dormancy (Ewart, 1908; White, 1908). Interference of seed coat with water uptake is observed in some crops of leguminosae family (Barton, 1965; Ballard, 1973 and Rolston, 1978). The removal of outer layers of seed coat resulted in loss of dormancy and removal of entire seed coat enhanced the germination percentage in groundnut (Toole *et al.*, 1964 and Patil, 1967).

The reason ascribed for failure of freshly harvested seeds of non-dormant variety (TMV 2) to germinate was the resistance offered by its seed coat for oxygen infusion (Sreeramulu and Rao, 1968). When the seeds of dormant (TMV 1) and non-dormant (TMV 2) varieties were compared for their capacity to absorb water, non-dormant variety (TMV 2) was found to be more efficient in absorption of water than dormant variety (Vaithailingam and Rao, 1973b). On the contrary, it has been reported that testa in groundnut is thin and does not affect the rate of imbibition of water by the embryo and hence does not affect the dormancy (Samad and Pearce, 1978).

Water soluble growth promoting hormones were found in non-dormant seeds of TMV 2 of groundnut variety, the seed coat extract of which induced root initials in dormant seeds of TMV 3 (Nagarajan and Gopalakrishnan, 1958). Studies of Joshi *et al.* (1980) indicated that the relative amount of inhibitors and promoters in the seed coat at any time, would regulate the dormancy in groundnut seeds. It was noticed that high levels of auxin like substance in the seed coat of non-dormant seeds which had root inducing activity (Sreeramulu and Rao, 1971a). On the contrary, when the non-dormant TMV 2 seeds were tested for germination in the extract of dormant TMV 1 seeds, there was retarding effect on the shoot and root development (Viathialingam and Rao, 1973a).

Of the various seed parts, the leachate from the seed coat of dormant seeds was found to be most inhibitory and this inhibition gradually disappeared with the release of dormancy. Further, decoating of dormant seeds during dormancy gave an increased germination initially, followed by a fall. This may possibly be attributed to decrease in the

inhibitor : promoter ratio in the seed coat with an advance in the post harvest period (Joshi *et al.*, 1980). But the studies of Sengupta *et al.* (1977) indicated that, as tightly attached seed coat delayed the germination and its removal enhanced the germination in some cultures of both bunch, spreading and semi spreading groundnut seeds. Ashok Kumar (1989) reported that the cultures, DER, ICG 118, ICG 9489, ICG 11498 and ICG 1497 have coat imposed dormancy. Venu *et al.* (1995) observed that the whole seed dormancy was higher in both spanish and Virginia types as compared to embryo dormancy.

Bandyopadhyay *et al.* (1999) observed that seed testa played an important role in imparting dormancy followed by cotyledons and embryonic axis and also they revealed that dormancy in groundnut is mainly regulated by testa (maternal tissue) in the Spanish type.

2.3 Stability of dormancy

The character dormancy is highly plastic in nature and it shows very high seasonal fluctuations (Ashok Kumar, 1989). Dormancy in groundnut was seen to be a function of temperature and time of storage (Hull, 1937). It was noticed that the period of dormancy contracted as the storage temperatures increased from 3 to 40°C. In case of dormant spreading ground nut varieties inverse relationship between high storage temperature and duration of dormancy was reported by John *et al.* (1948). The duration of dormancy can be shortened to 15 days by exposing the seeds at 40 to 50°C (Baiely *et al.*, 1958). Similar seasonal variation in dormancy period of groundnut has been reported by Gavrielith (1962), Mcfarland and Smith (1966) and Gautreau (1984). Seeds in attached pods of *fastigiata* lines germinated gradually only if the plants are healthy and well watered (Wadia *et al.*, 1987). Such instability in duration and intensity of dormancy as is observed in various crops prompted Naylor *et al.*, (1979) to term primary dormancy as a transient physiological trait rather than a discrete at any time.

2.4 Fresh seed dormancy

Appreciable dormancy observed in the freshly harvested seeds of several bunch groundnut cultivars, which disappears after curing is called fresh seed dormancy.

Sreeramulu and Rao (1968) reported that freshly harvested seeds of TMV 2 show only 50 per cent germination and this is due to high moisture content of the seeds which blocks oxygen diffusion. Occurrence of fresh seed dormancy, which disappeared after seven days of curing has been reported in several spanish and Valencia bunch cultivars by Wadia *et al.* (1987). CGS 1-19 (CGC 7), a new Spaniash bunch ground nut cultivar has been identified with fresh seed dormancy in cross between J-11 X Robut 33-1 (Reddy *et al.*, 1985). Ashok Kumar (1989), also observed fresh seed dormancy in some of the non-dormant cultures.

Asibuo *et al.* (2008) showed that the F₁ progenies obtained from crosses between dormant (ICGV-86158 and ICGV-87378) and non-dormant parent (Shitaochi and Aprewa adopted varieties in ghana but lack dormancy) were dormant. Where F₂ progenies fitted the expected 3 dormant to 1 non-dormant ratio. Thus concluded that fresh seed dormancy is controlled by monogenic inheritance with dormancy dominant over non-dormant.

Faye *et al.* (2010) studied the inheritance of fresh seed dormancy in Spanish x Spanish crosses with two sets of segregating populations, in which an F₂ population derived from true F₁ hybrids identified with peanut micro satellites markers and other populations (F₂, BC₁, P₁s and BC₁P₂s) from randomly selected F₁ individuals are used. Here the results revealed that in the F₂ population developed with true F₁ hybrids, the chi-square test was not significant for the deviation from the expected 3:1 (dormant : non-dormant). In addition the bimodal frequency distribution curve with the F₂ population gave more evidence that fresh seed dormancy is controlled by single dominant gene. Therefore, fresh seed dormancy in Spanish varieties is qualitative in nature.

2.5 Variability for dormancy

The cultivated groundnut (*Arachis hypogaea* L.) consists of two subspecies, viz., *fastigiata* and *hypogaea*. The cultivars belonging to subsp. *fastigata* are generally characterized by a short life cycle and non-dormant seeds, while, those of subspecies *hypogaea* gene Lally mature late and their seeds show dormancy for considerable length of

time after maturity (John *et al.*, 1948 and Krapovickas, 1968). Among the different maturity groups, viz., Spanish bunch (SB), Virginia bunch (VB) and Virginia Runner (VR), which showed significant variation for dormancy, the VR exhibited maximum seed dormancy followed by VB, while, the SB had the lowest frequency of dormancy (Yadav *et al.*, 1989).

Patil and Bhapkar (1987) observed highest phenotypic and genotypic variances for seed dormancy in groundnut. A study involving 417 genotypes of groundnut belonging to different botanical groups, showed wide range of variability for different dimensions of dormancy intensity and duration (Presannakumari and Namboodiri, 1996). Pandya and Patel (1986) identified dormant cultures both in Virginia (G 201, ICGS 6 and Robut 33-1) and Spanish (ICGS 21, ICGS 30 and ICGS 57, TG 9, TG 17 and RSHY 6) groups from screening four Virginia and 73 Spanish cultures). It was observed that there is variation for dormancy in both Virginia bunch and Virginia Runner type groundnut (Zade *et al.*, 1986, Kenoni *et al.*, 1993 and Sarala and Gowda, 1997). The experiments conducted over three seasons by Ashok Kumar *et al.* (1989) resulted in identification of 16 bunch cultivars as dormant. Among them high intensity of dormancy was observed for Dharwad Early Runner (DER), ICGS 30, ICG 11498 and ICG 11493 over at least two of the three seasons whereas the cultures ICGS 11, ICG 118 and ICG 11495 fluctuated widely for intensity of dormancy. The cultures Dh 8, DER, ICGS 30 and ICGS 57 were found to have more than three weeks of dormancy in all the three seasons tested. A period of 2-3 weeks of dormancy was exhibited by ICG 11499, 11501, 11493, 118, 11497 and ICG 6810.

Duration of dormancy ranged from 9 to 50 days in Spanish bunch and valencia groups while, in runner group it ranged from 110 to 210 days (Hull, 1937). Screening of 206 bunch varieties for seed dormancy 15-20 days after maturity, resulted in the identification of six varieties with more than 90 per cent seed dormancy of which Ah-7851 had 95 per cent dormancy and Ah 1716, Ah 7813 had only 5 per cent dormancy (Muhammad and Dorairaj, 1968). Similarly, Lin and Chen (1970) observed significant differences in the length of the dormancy period among the 56 varieties screened by them. Thirumalaswamy *et al.* (1987), observed less pre-harvested sprouting (8-10%) in some of the bunch varieties at 140 days after sowing.

Naidu (1997) investigated to isolate dormant groundnut genotypes with desirable agronomic traits from various crosses. Here the genotype \times season showed significant interaction for intensity and duration of dormancy. The entries JL-24, KRG-1 and Dh-40 were non dormant, but lacking in one or the other productivity parameters and/or earliness. GBFDS 272, CS-16, VLI and VL 1-45 showed fresh seed dormancy. The PCV and GCV indicated moderate to high level of variation for dormancy (55.2-104.9) and low variation for shelling per cent and hundred kernels weigh (1.9-17.9). Though heritability for dormancy was low to moderate (17.6-53.4%), the genetic gain was moderate to high (28.3-115.4%).

Swain *et al.* (2001) analyzed the nature of variation for seed dormancy in 17 erect, 8 semi-spreading and 5 spreading varieties. Dormancy period (DG100) of the varieties ranged from 33 to 107 days and dormancy intensity (NGH0), from 54 to 100 per cent. The range of variation and PCV and GCV indicated presence of substantial genotypic variability for dormancy period and intensity. Most the erect varieties showed short to medium dormancy period and weak to moderate intensity and most semi-spreading and spreading varieties possessed long dormancy period coupled with strong intensity of dormancy.

Naidu *et al.* (2003) revealed that seasonal variation existed for both intensity and duration of dormancy, among the nine released cultivars of Karnataka only Dh-8 and ICGS-11 were exhibited dormancy while KRG-1 exhibited fresh seed dormancy. All the non-dormant cultivars had higher germination in summer than *kharif* season produced except KRG-1 due to its fresh seed dormancy.

Diop and Faye (2009) showed strong similarity between the field test and the laboratory test for seed dormancy. Where intensity of dormancy ranged from 12 per cent for lines L6 to 100 per cent for line L2 and L4. These latter lines exhibited dormancy duration longer than 35 days while the line L6 showed a period of dormancy of one to two weeks. On the basis of the dormancy scale used, the rate of the degree of seed dormancy for the lines used from level 3 for the line L6 which was the least dormant line to level 8 for the lines L2 and L4 which were the most dormant lines.

2.6 Inheritance of dormancy in groundnut

The highly plastic nature of dormancy because of the complexity of character expression and environmental sensitivity has discouraged extensive studies on the genetics of dormancy in groundnut. The study on dormancy is further complicated by non-synchronous pod formation coupled with differential maturity. As dormancy is controlled by the embryo or can be imposed by the extra embryonic tissues which are of different genetic constitution, *viz.*, the seed coat (diploid), the endosperm (triploid) and the embryo (diploid). Therefore the prospect of discovering straight forward mendellian inheritance of dormancy is slight. Also the seed is composed of parts of three distinct generations, *viz.*, the seed coat (maternal), the endosperm (filial) but with one paternal and variable number of maternal genomes along with embryo (filial) (Bewely and Black, 1985 and Garbutt and Witcombe, 1986) and one or more of these tissues may be associated with the cause of dormancy thus complicating the issue. The resulting contradictory reports leave the genetics of dormancy in groundnut a foggy issue. Dormancy was found to be partially dominant over non-dormancy (Stokes and Hull, 1937 and Ramchandran *et al.*, 1967). In one case, dormancy was reported to be completely dominant over non-dormant nature (Lin and Lin, 1971a) with single gene(D) controlling the character and in F_2 some deviations from the expected 3:1 ratio was observed possibly because of the unstable varieties used in the crosses (Lin and Lin, 1971b). Contrary to this, a single pair of recessive genes were held responsible for dormancy (Chang, 1972), whereas, possibility of multiple factors controlling the character (Hull, 1937) was not ruled out by John *et al.*, (1948), who, in erect x runner crosses observed intermediate dormancy of F_1 and considerable variability in F_2 generation. Khalfaoui (1991) in a study involving cross between spanish dormant 73-30 and Spanish non-dormant Chico, observed that genetic control is not very complex (additive, dominance and digenic epistatic effects) which is further supported by average broad sense heritability (0.49 to 0.57) and narrow sense (0.54) heritability estimates.

Upadhyay and Nigam (1999) studied different populations from many crosses and found that seed dormancy in that peanut type is controlled by a single gene and dormancy allele is dormant.

Ndoye and Charles (2001) studied three crosses between Spanish varieties and reported that beyond additive and dominant effects, there is duplicate epistasis in the control of fresh seed dormancy.

Asibuo *et al.* (2008) revealed that the F_1 progenies from crosses between dormant parents (ICGV-86158 and ICGV-87378) and non-dormant exotic varieties (Shitaochi and Aprewa widely grown in ghana but lack dormancy) were dormant. Wherein F_2 progenies fitted in expected 3 dormant to 1 non-dormant ratio. Thus revealed that fresh seed dormancy is controlled by monogenic inheritance.

Faye *et al.* (2010) they revealed more evidence that fresh seed dormancy in Spanish x Spanish crosses is controlled by single dormant gene. Therefore, fresh seed dormancy in Spanish varieties is qualitative in nature. Pedigree selection from an F_2 population could be suggested to effective strategy to obtain peanut lines with earliness and fresh seed dormancy.

2.7 Breeding for dormancy

There are some cultivars which have been identified as source material for dormancy and they can be used in breeding programmes so as to get early maturing and good yielding varieties which is the aim in any breeding programme in groundnut. Gowda *et al.* (1989) identified a new growth habit variant in cross between Dh-3-30 x CGC 1, which had some characters of *Arachis hypogaea* sub spp *hypogaea* such as trailing branches, a short main axis and 50-60 days seed dormancy and some of subsp. *fastigiata* including a short growth period. Therefore, it is suggested, this new culture can be used to introduce seed dormancy into spanish bunch Valencia groups. Varman and Raveendran (1991) identified another variety ICGV 86011 derived from the cross (Dh-3-30 x UAS 20) x NcNc 2232, which had seed dormancy of 18 days and can be used to breed for dormancy. CGC 7 a Spanish cultivar, derived from a cross between Spanish cultivar J11 and Virginia bunch cultivar Robut 33-1, had seed dormancy period of 5 weeks (Reddy *et al.*, 1987). This can be used as source for breeding dormancy in the cultivars.

Nautiyal and Bandyopadhyay (2001) revealed that wide range of variability exists for fresh seed dormancy in Spanish groundnut and suggested that Spanish type cultivars SB XI had a high degree of fresh seed dormancy and it may be used as a donor in breeding programme for preventing *in situ* sprouting of seed.

Faye *et al.* (2009) conducted the study on seven (7) advanced peanut lines developed from crosses between the dormant Spanish type variety (73-30) and two non dormant Spanish type varieties (55-437 and Fluer 11) and the results suggested that dormant variety (73-30) could be used as donor parent in breeding programmes to select lines with fresh seed among Spanish x Spanish crosses.

Faye *et al.* (2010) conducted the study for fresh seed dormancy in Spanish x Spanish crosses and gave more evidence that fresh seed dormancy is controlled by single dominant gene and it is qualitative in nature and suggested that pedigree selection from an F₂ population could be suggested to be an effective strategy to obtain peanut lines with earliness and fresh seed dormancy.

2.8 Selection for dormancy in groundnut

As there is no clear idea about the genetics of seed dormancy in groundnut and the urgent need for evolving dormant bunch cultivars, the plant breeders are left with three options, *viz.*, identification of dormant lines from available germplasm (Muhammad *et al.*, 1965), intersubspecific hybridization (Ramachandran *et al.*, 1967) and intrasubspecific hybridization (Huang, 1981) have demonstrated their efficacy in coming up with a dormant high yielding genotype. One potentially high yielding Spanish bunch dormant culture, CGC 7 that has been derived from the cross J11 x Robut 33-1 (Reddy *et al.*, 1985) is being used as a donor of dormancy in crossing programmes (Pandya and Patel, 1986).

The study of yield and its components and general desirability criteria allow less scope for direct utilization of identified dormant cultures for varietal development (Ashok Kumar, 1989).

Despite the efforts, the progress by selection is slow because of lack of simple breeding methodology. One of the simple methodologies suggested is to collect the pods from the F₁ plants of a bunch x semi spreading cross and test for germination in trays 30 days after harvest (the required period of dormancy). The ungerminated seeds are treated with ethrel to break dormancy and planted in the field to grow F₂, the bunch type plants alone are tagged. Single seed descent method followed until F₅ or F₆ (at each stage, the ungerminated and ethrel treated seeds alone are planted) results in considerable homozygosity after which single plant progenies can be evaluated for dormancy in F₆/F₇ generation and superior lines combining dormancy and yield selected (Manoharan *et al.*, 1989). Mauboussin (1966) obtained an early maturing dormant cultivar (73-30) by pedigree selection from a Spanish x Virginia cross. Khalfaoui (1991), suggested that pedigree selection can be successfully carried out in Spanish type cultivars using 73-30, which is a dormant early maturing cultivar as a parent, as broad sense and narrow sense heritabilities ranged from 0.49 to 0.57 in the cross involving this with Chico, a early maturing non-dormant cultivar.

Significant improvement in the frequency of dormant types in F₃ was recorded upon selection for dormancy in F₂ (Ashok Kumar, 1989). of the two methods - bulking and forwarding the remaining seeds of dormant tested plants within a cross and bulking of companion seeds of plants from same cross where one seed of a two seeded pod showed dormancy the latter showed greater efficiency in selecting for dormancy in early generations.

In a study, 15 crosses involving non-dormant and dormant parents and two crosses involving only dormant types, the proportion of dormant plants in F₁ generation upon mass selection in F₂ was substantially higher (52% in NO x O and 94% in O x D crosses) indicating its good response for selection. The response to selection for productivity in early generations was very poor. But the fact that the dormant and non-dormant plants, both in F₂ and F₃ generations did not substantially differ for productivity parameters suggested that the best strategy for breeding dormant productive cultivars should be to select for dormancy in early generations and defer the selection for productivity to later generations (Hemanth, 1990).

Ousmane and Chasles (2000) thirty lines were evaluated from the crosses between Spanish cultivars i.e., Spanish cultivator (73-30) with fresh seed dormancy as donor parent and Spanish cultivar (55-437 and Fleur 11) that lack dormancy. Here the lines that exhibited transgressive segregation were observed. Most of the lines belong to cross 55-437 x 73-30 as compared fewer lines in the cross Fleur 11 x 73-30 due to the fact that Fleur 11 is less dormant than 55-437. Thus concluded that by using this technique it was possible to make effective selection for fresh seed dormancy in short duration.

Nautiyal and Bandyopadhyay (2001) reported that fresh seed dormancy in SB XI remains for only 2-3 days and disappears during the drying and storage, whereas the dormancy in M13 persists during drying and even after 40 days of storage and concluded that regulation of fresh seed dormancy in groundnut seems to be a complex phenomena and finally suggested for the cultivation of groundnut in Indian agro-ecological systems. Fresh seed dormancy as reported in SB XI, is more desirable than the type of dormancy in M 13. Where cultivars SB XI could be used as donar in breeding programme for incorporation of fresh seed dormancy in Spanish type.

Asibuo *et al.* (2008) conducted the study to determine the heritability of fresh seed dormancy in groundnut and to transfer this trait from exotic lines (ICGV 86158 and ICGV 87378) known to possess dormancy, into genetic background of two groundnut varieties (Shitaochi and Aprewa) widely grown in Ghana but lack dormancy. But the result revealed F₁ progenies were dormant from crosses of dormant and non-dormant parents and F₂ progenies tested the excepted 3 dormant to 1 non-dormant ratio.

2.9 Association of dormancy with other characters

Characters like dormancy, which need lab tests for observation, are conveniently selected if some associations are identified between dormancy and other visible plant characters. This association will also make early generation selection easy.

Character association with dormancy are rare in groundnut. In general, it is presumed that seeds from bunch type of groundnut varieties are non-dormant and those of semi-spreading varieties are dormant (John *et al.*, 1948). But this association of dormancy with plant habit cannot be generalised as there are several reports demonstrating the existence of dormant cultures in bunch types (Patil, 1967; Muhammed and Dorairaj, 1968; Muhammed *et al.*, 1965; Wadia *et al.*, 1987; Upadhyaya *et al.*, 1997). Some associations, however, have been seen in groundnut, like dormancy of seeds was seen associated with maturity (Toole *et al.*, 1964), dark green colour of leaves was reported to be associated with dormant nature of seeds (Ramachandran *et al.*, 1967).

Dormant seeds produce low amount of ethylene than the non-dormant seeds. Seedling vigour is found associated with the pattern of ethylene production (Venu, 1993). However, dormancy did not exhibit significant association with any of the morphological characters, like main stem length, primary branch length, number of primary branches, number of secondary branches and number of reproductive nodes on primary branch, indicating its independent genetic control (Sarala, 1993 and Diddimani, 1996). Nautiyal *et al.* (1997), in an experiment on accelerated ageing using dormant and non-dormant genotypes have reported that seedling vigour is more in case of dormant genotypes than in non-dormant genotypes.

Martin (1999) noticed that the yield losses due to sprouts of Spanish varieties are considerable and range from 10-20 per cent of the pod yield and also the sprouting is to increase the susceptibility of parent to aspergillus infection, which can result to the aflatoxin contamination.

2.10 Variability for productivity traits

Among the various oil seed crops, groundnut is a unique commercial crop and has been aptly described as “nature’s” master piece of food value. Pod yield in groundnut, a quantitatively inherited complex trait, is the result of number of cumulative, duplicate and dominant genes and highly influenced by G x E interaction. This necessitates a thorough knowledge of variability owing to genetic factors.

Further, a comprehensive knowledge on the interrelationship between yield determining characters and their association for enhancement of yield is of paramount determining character and their association for enhancement of yield is of paramount importance in crop improvement.

Many agronomically important traits in groundnut are quantitatively inherited (Murthy and Reddy, 1993). Additive, non-additive and epistatic genetic effects are reported for pod yield, pods and seeds per plant, pod length and shelling outturn (Parker *et al.*, 1970, Layrisse *et al.*, 1980, Dwivedi *et al.*, 1989, Upadhyaya and Nigam 1998).

In an experiment conducted by Deshmukh *et al.* (1986), the results revealed that heritability for plant height, 100 pod weight, 100 kernel weight, shelling out turns and oil content. Hundred pod weight and 100 kernel weight also expressed high genetic advance, indicating the role of additive gene action in controlling these traits. They indicated the possibilities of selection response based on phenotypic expression.

Deshmukh *et al.* (1987) studied 25 Virginia runner varieties of groundnut and observed high genotypic coefficient of variation coupled with high heritability and genetic advance for 100 pod weight followed by 100 kernel weight, suggesting predominant role of additive gene action in manifesting of the traits and phenotypic selection was fruitful for improvement of these traits.

Vaddoria and Patel (1990) estimated genetic parameters for 9 traits from 50 accession of Virginia groundnut. They observed high heritability coupled with high genetic advance for pod yield per plant, pods per plant and 100 kernel weight and moderate for branches per plant and days to 50 per cent flowering, days to maturity, shelling out turns and oil content recorded moderate genetic advance. They concluded that characters *viz.*, pods per plant, 100 kernel weight and shelling out turn provided good opportunities for improving pod yield.

Mishra and Yadav (1992) reported high genotypic coefficient of variation for 100 kernel weight, dry pod and kernel yield and plant height in groundnut. High heritability and genetic advance were also observed for these characters.

Reddy (1994) analyzed variability by recording information on yield and 11 yield components in 48 genotypes of Spanish groundnut. He reported that the values of phenotypic coefficient of variation were in general, higher than the genotypic coefficients of variation for all the characters. High genotypic and phenotypic coefficients of variation were recorded for number of secondries, pod yield, haulm yield, 100 pod weight and 100 seed weight. The heritability estimates were high for 100 pod weight, number of secondries, harvest index, 100 seed weight, height of main axis and shelling percentage.

Venkataramana (2001) from the evaluation of 30 groundnut genotypes stated that genotypic coefficient of variation was high for oil content, pod yield, 100 kernel weight and kernel yield. Heritability (broad sense) estimates were high for oil content, 100 kernel weight and sound mature kernel percentage. High heritability coupled with high genetic advance was observed for 100 kernel weight.

Dashora and Nagda (2002) studied twenty two germplasm lines for seven characters in which dry pod yield, 100 kernel weight and kernel yield had high genetic advance and estimates for heritability.

Singh (2005) studied 163 genotypes of groundnut for different characters to assess the genetic variability, heritability and genetic advance and reported that high percentage of genetic advance were recorded for number of pods and pod yield per plant, which indicated that there were more number of additive genes for these characters and improvement in pod yield could be brought about by selection based on phenotypic observations. Number of pods per plant and 100 kernel weight expressed highly significant and positive phenotypic genetic association with pod yield per plant.

Parameshwarappa *et al.* (2005) studied 48 diverse large seeded groundnut genotypes and reported the presence of high genetic variability for number of primary branches, pod yield per plant, kernel yield and plant height. Considerable variability was also noticed for number of pods, 100 kernel weight and seed size and protein content.

However, variability observed for oil content and sound mature kernels was low. High heritability coupled with genetic advance was noticed in respect to kernel yield, sound mature kernels and 100 kernel weight. The extent of genetic advance was quite low for kernel size, protein content and oil content.

Kadam *et al.* (2007) studied 40 groundnut genotypes of different botanical groups to assess the amount of genetic variation, heritability and genetic advance with respect to pod yield and other agronomic characters. The genotypic coefficient of variation was high for kernel yield, pod yield, number of pods, number of branches, plant height and harvest index. High heritability coupled with high genetic advance was observed for pod yield and kernel yield.

Kumar *et al.* (2008) studied sixty four genotypes (39 accessions and 25 advanced breeding lines) of groundnut and reported wide range of variability. The estimates of genotypic and phenotypic coefficient variations were moderate for plant height, matured pods per plant, pod yield per plant, kernel yield per plant, shelling percentage, 100 kernel weight, harvest index and specific leaf area. High heritability coupled with high genetic advance was noticed for all the characters under study except for days to 50 per cent flowering, days to maturity, sound mature kernel per cent and oil content.

Khote *et al.* (2009) studied fifty six groundnut genotypes for genetic variability, heritability, and genetic advance for yield and yield contributing characters. Higher phenotypic and genotypic coefficients of variations were observed for dry fodder yield per plant followed by dry pod yield per plant. High heritability values were recorded in respect to 100 dry pod weight, number of days to maturity, oil per cent in kernels, pod length and dry fodder yield per plant. The characters which showed high genetic advance as per cent of mean were dry fodder yield per plant, dry pod yield per plant, leaf area, number of pods per plant, number of sound mature kernels per plant and 100 dry pod weight.

2.10.1 Test weight (g)

Hundred seed mass is quantitatively inherited trait controlled by additive, dominance and epistatic effects (Garet, 1976, Sandhu and Khera, 1976, Layrisse *et al.*, 1980, Arunachalam *et al.*, 1984, Upadhaya and Nigam 1998).

Pod yield possessed significant positive association with kernel yield, test weight and oil yield at both genotypic and phenotypic levels (Laksmidevamma *et al.*, 2004).

The size of kernel is one of the important factors for export. Normally varieties with hundred seed mass of 60 g or more are considered as large seeded groundnut and are preferred for confectionary purpose. Large seeds of groundnut have a greater consumer performance and fetch higher prices in domestic and international markets. Birsa 1 was one of the first confectionary varieties released for cultivation in India (Rahaman *et al.*, 1995) in pod/seed yield and 15 per cent in 100 seed mass.

Highest pod yield per plant was reported in *hypogaea* group with the range of 6.68 to 11.49 g) rather than *fastigiata* group ranged from 3.69 to 8.76 g (Mallikarjuna Swamy *et al.*, 2003). They also reported that pod yield per plant had a significant negative correlation with oil content and positive correlation with test weight.

2.10.2 Shelling per cent

Many agronomically important traits in groundnut are quantitatively inherited (Murthy and Reddy, 1993). Additive, non-additive and epistatic genetic effects are reported for pod yield, pods and seeds per plant, pod length and shelling outturn (Parker *et al.*, 1970, Layrisse *et al.*, 1980, Dwivedi *et al.*, 1989, Upadhaya and Nigam 1998).

Upadhaya (2003) reported significant variation for shelling per cent between *hypogaea* and *fastigiata* showed higher shelling per cent than *hypogaea* accessions of which 910 belonged to sub spp. *fastigiata* and 794 to sub spp. *hypogaea*.

Genetic variability components revealed high heritability for shelling per cent, 100 seed weight and low for pod yield per plant (Upadhaya *et al.*, 2005 and Vasanthi *et al.*, 1998).

2.10.3 Late leaf spot and rust

The foliar diseases *viz.*, late leaf spot and rust are commonly present wherever the groundnut is cultivated. Each disease alone is capable of causing substantial yield loss but when they occur together losses are further increased up to 70 per cent in India (Subrahmanyam *et al.*, 1980). These diseases also have an adverse influence on the recovery of pods, quality of seeds and haulms.

Rust is one of the most destructive fungal diseases in almost all groundnut-growing areas of the world. It is caused by *Puccinia arachidis* Speg. and first noted by Spegazzini (1884). The disease occurs in most of the groundnut growing Indian states and more intensively in South Indian states as conditions favours the development and spread of the disease (Subrahmanyam and McDonald, 1982). Pod loss caused by rust reach 50-80 per cent in epidemic year (Sandhikar *et al.*, 1989).

The *Cercospora* or tikka leaf spots (Early and late leaf spots) are the most important foliar fungal diseases of groundnut. Late leaf spot distributed throughout the world and more predominant compared to early leaf spot because of its fast spreading nature. It is caused by *Cercospora personatum* (Berk and Curt) and was described in USA in 1875. The perfect stage *Mycosphaeselles berkeleyii* was described by Jenkins (1938). But, recently, it was renamed as *Phaeoisariopsis personata* (Berk and Curt) V. Arx.

Reys and Romasata (1940) reported that leaf spot lesions are not only confined to the leaf lamina, but may occur on petioles, stems and pegs leading to direct deterioration of the developing pods. Leaf spot causes damage by causing lesion formation, reduction in photosynthetic area by way of defoliation (Boote *et al.*, 1980) and premature leaflet abscission. Generally, 10 to 15 per cent yield losses were reported due to late leaf spot (McDonald *et al.*, 1985) worldwide and reduced seed yield could be due to reduction in dry weight, chlorophyll, protein and sugar (Ghosh and Biswas, 1995).

Sources of resistance to both early and late leaf spot have been identified in *Arachis hypogaea* (Chiteka *et al.* 1988; Anderson *et al.* 1993). Very high level of resistance to late leaf spot has been found in wild species of groundnut (Stalker and Simpson 1995) and used to develop breeding lines with resistance (Gorbert *et al.* 1982; Melouk *et al.* 1984; Wells *et al.* 1994; Xue and Holbrook 1998). Programmes are going on to introgress this resistance into *A. hypogaea* (Stalker and Beute 1993).

Dinakaran *et al.* (1992) conducted separate field evaluations of disease damage caused by late leaf spot and rust with 28 groundnut genotypes and the standard cultivars JL-24 and TMV-2. Their study revealed that PI-215696, NCAC-927, EC76446 (292), PI350680 and PI259747 were resistant to both diseases.

Gopal *et al.* (1993) screened 56 groundnut genotypes for late leaf spot and rust diseases during the rainy season (1990). The results showed that 2 Spanish, 3 Virginia bunch and 5 Virginia runners were resistant to both diseases.

Gopal *et al.* (1994) evaluated six genotypes and four susceptible controls Girnar 1, JL-24, TMV-2 and KRG-1 for late leaf spot and rust resistance. R 8972 was the most resistant to LLS and rust with scores of 3.0 and 2.5, respectively.

Aquino *et al.* (1995) found that latent period and maximum percentage of lesion that sporulated were the components of resistance most highly correlated with late leaf spot diseases development. They suggested that using either of these two components to evaluate breeding populations might facilitate more rapid selection of lines with improved levels of rate reducing resistance.

Vasanthi *et al.* (1998) reported a significant and positive association of leaf spot and rust severity with shelling percentage. By studying the eleven elite lines developed at ICRISAT and three varieties for late leaf spot and rust, which showed high heritabilities of 96.55 and 93.28 per cent, respectively.

Until the release of 'Southern Runner' in 1984, no commercial cultivar was available with meaningful resistance to late leaf spot (Gorbet *et al.*, 1999). Holbrook and Isleib (2001) observed that screening of 13000 accessions at IAC led to the identification of 69 genotypes resistance to LLS (Mehan *et al.*, 1996). Forty-nine of these resistance sources were land

races from Peru. Out of 69 LLS resistant genotypes only 19 were being used in breeding programme. Only one of them (ICG 4747) had resulted in release of resistant cultivars as ICG (FDRS) 4 and ICGV 86590 from IAC and Girnar 1 from Indian national programme. Some resistant accessions from Peru are ICGS-10920, ICGS-11182, and ICGS-12720.

Gowda *et al.* (2002) developed GPBD-4 an early maturing resistant variety of late leaf spot and rust from the cross KRG-1 × ICGV-86855.

Reddy *et al.* (2004) studied molecular diversity among genotypes for resistance to late leaf spot and rust in groundnut. The susceptible lines clustered distinctly away from the resistant group and GPBD-4 occupied a distinct cluster.

The effect of important diseases of groundnut and sorghum on pod and grain yield and crop residue yield and quality. In four genotypes of groundnut, late leaf spot (*Phaeoisariopsis personata*) and rust (*Puccinia arachidis*) are the two major foliar diseases that together could reduce pod and haulm yield by 70% and in vitro digestibility of haulms by 22%. Two genotypes (ICGV 9202 and 92093) were highly resistant to these foliar diseases maintaining high pod and haulm yield as well as high in vitro digestibility of haulms (>62.3%) even under highest disease pressure. (Bandyopadhyay *et al.*, 2003).

Mondal *et al.* (2005) studied nineteen groundnut genotypes with varying resistance to late leaf spot and rust VG-9514, TFDRG-5, GPBD-4, DTG-27, DTG-57, DTG-58, DTG-60, TDG-56 and Mutant 28-2 resistant to both diseases.

2.10.4 Nutritional quality traits

2.10.4.1 Oil content

The oil content of kernels shows significant genotypic variations. The crop season, habit group, geographical location, soil fertility, moisture availability, maturity crop at harvest seed mass etc. have a bearing on the oil content.

The oil content of groundnut produced in India may vary from 42 to 55 per cent. Rao *et al.* (1965) have reported the widest range of (42.3 to 56.5%) oil content on the basis of analysis of 121 genotypes.

Tai and Young (1975) reported that oil content is quantitatively inherited, while Martin (1967) estimated that only two pairs of major genes control oil content in peanut seeds. Martin (1967) and Patil (1972) obtained high heritability estimates of oil content.

Cherry (1977) determined the quantity of oil from 37 selected wild species and 21 cultivars and found that oil content in seeds was 46.50 to 63.10 per cent for wild species and 43.6 to 55.50 per cent for the cultivars. The oil content of groundnut has been reported to range from 35.80 to 54.20 per cent and average near 45 per cent (Jambunathan *et al.*, 1985 and Dwivedi *et al.*, 1990).

Cultivars Dh 3-20, NCAC 17494, NCAC 17278, NCAC 17500, S.Am. Coll 79, TMV3, TG 7 and TMV 10 have been reported to contain 52 per cent or more oil (Nagaraj *et al.*, 1986).

Raheja *et al.* (1987) and Bansal *et al.* (1993) reported that the oil content of groundnut genotypes is independent of habit group (*Virginia runner*, *Virginia bunch* and *Spanish bunch*).

Oil content is generally higher in kernels obtained from the crop grown in summer season (dry irrigated conditions) than those from rainy season (Nagaraj and Chauhan, 1987).

The oil content is also influenced by the maturity of the crop at harvest. The oil content increases with advancing maturity in most cultivars (Nagaraj *et al.*, 1987).

On the basis of analysis of graded samples of 33 genotypes, Dwivedi *et al.* (1990) observed that oil content could not be significantly correlated with seed mass (size) across the genotypes. Generally, within a genotype, oil content (%) increased with the increasing mass of seed.

The oil content differs considerably with geographical locations of crop growth in India. On the basis of an experiment conducted by cultivating eight Virginia groundnut cultivars in five different geographical locations in the country (Junagadh, Jalagaon, Dharwad, Khargaon and Chintamani), Nagaraj *et al.* (1984a) concluded that the highest oil content was observed in the seeds obtained from Junagadh (Gujarat) while the lowest was in the seeds from Dharwad (Karnataka).

Compared to refined oil, raw groundnut oil is fairly stable because of its iodine number, saponification number, acetyl number and free fatty do not change during heat treatments and hence, groundnut oil is highly reusable. Besides, groundnut oil can be stored at room temperature for 18 months without significant deterioration in quality. Hence, groundnut oil is considered as an excellent cooking medium (Misra *et al.*, 2000).

Peanut (*Arachis hypogaea* L.) is an important oilseed crop worldwide because oil comprises ~ 50 per cent of its seed dry weight (Isleib *et al.*, 2004).

2.10.4.2 Protein content

Groundnut kernels are considered as important source of vegetable protein, as it is the second most abundant constituent of kernel after oil. The protein content shows considerable genotypic variations and is affected by crop reason, location, soil moisture and nutrient availability etc. Groundnut protein is increasingly becoming popular as food and feed source, especially in developing countries where protein from animal sources is not within the means of majority of the population. The groundnut kernels contain more protein than meat, eggs and most of other vegetables. This is especially important for children.

Punnoose and George (1974) have reported that the application of nitrogen or phosphorous or both leads to increase in protein content.

Pancholy *et al.* (1978) reported crude protein content of whole seed groundnut range between 22 to 30 per cent showing large variation which is generally influenced by genotype and environmental conditions.

The development of nutritionally balanced foods to feed the growing population of dietary deficiencies of proteins is receiving increasing attention of the food scientist and nutritionists, oilseeds are used to manufacture and market high protein foods at reasonably low prices (Bookwaltes *et al.*, 1979).

Gupta *et al.* (1982) reported protein content to be in the range of 24.05 to 33.25 per cent among twenty five genotypes grown at Hissar (Haryana).

The protein content of groundnut kernels is generally determined by multiplying the nitrogen content with a nitrogen-to-protein conversion factor. Some authors have used a factor of 5.46 (Nagaraj *et al.*, 1984a, Dwivedi *et al.*, 1990, Jambunathan *et al.*, 1993, Misra *et al.*, 2000) while the others have used a factor of 6.25 (Gadgil and Mitra, 1983, Bangar *et al.*, 1997). Obviously depending upon the conversion factor used, the protein content of samples containing same nitrogen content may be reported to be different from each other.

Nagaraj *et al.* (1987) reported that unlike oil content, the protein content of kernels is not much affected by the maturity status of the at harvest.

Reddy *et al.* (1987) indicated that the seeds of groundnut contain 25 to 32 per cent protein and the cake, the residual matter after oil extraction contains 46 to 60 per cent protein. Whereas, Gupta *et al.* (1982) reported the protein content in the range of 24.05 to 33.25 per cent among the 25 genotypes of groundnut grown at Hissar. A range of 16.00 to 34.00 per cent protein was observed in 8000 germplasm accessions analyzed at ICRISAT (Dwivedi *et al.*, 1993).

Jambunathan *et al.* (1993) have reported protein content in groundnut kernels in the range 20.0 to 30.8 per cent of five ICGS cultivars and two other cultivars.

The end-of-season drought results in increased protein content of kernels (Dwivedi *et al.*, 1996) and the kernels obtained from the rainy season generally contain higher protein than that of summer season.

Protein content varies much between accessions of botanical varieties but between accessions of botanical varieties it ranges from 16.10 to 34.00 per cent (Singh *et al.*, 1998).

The groundnut kernels contain high quality protein than meat, eggs and most of other vegetables. Hence, it is important for children, women and people eating more meatless meals (Misra *et al.*, 2000). In absence of adequate carbohydrate and fat in diets, dietary proteins are broken down to provide energy (4 Kcal/g).

Misra *et al.* (2000) reported protein content in the range of 18.6-26.0 per cent among 18 cultivars grown at Junagadh.

Groundnut protein comprises almost entirely of two globulins *viz.*, arachin (63%) and conarachin (33%). As both arachin and conarachin contain 18.3 per cent nitrogen, hence, the nitrogen protein conversion factor for groundnut is 5.46. However, there is possibility of variation in the value of nitrogen to protein conversion factor due to differences in genotypes and geographical locations (Misra *et al.*, 2000).

The protein content of the kernels obtained from the crop of rainy season is generally higher than that of summer season (Misra, 2004).

3. MATERIAL AND METHODS

A population of 268 F_{12} derived recombinant inbred lines (RILs) from the cross TAG 24 x GPBD 4 were utilized for the study. In the summer season, the experimental material was sown on 1st January, 2010 in a Randomized Complete Block Design (RCBD) with two replications. Each recombinant inbred line (RIL) was grown in a row of 2.25 m length with spacing of 30 cm between rows and 10 cm between plants. The crop was harvested on 24th April 2010. In the *kharif* season, the experimental material was sown on 26th June, 2010 in a Randomized Complete Block Design (RCBD) with two replications. Each recombinant inbred line (RIL) was grown in a row of 2.5 m length with spacing of 45 cm between rows and 10 cm between plants. The crop was harvested on 20th November 2010. Individual RIL harvested was evaluated for seed dormancy, nutritional traits (protein content and oil content), yield and yield related traits.

3.1 RILs population

Recombinant inbred lines derived from the crosses TAG 24 x GPBD 4 were used for genetic variability for seed dormancy of linkage map. This comprised 268 genotypes which segregated for agronomic trait, foliar disease reaction, nutritional and oil quality traits.

3.1.1 Salient features of parental material

TAG 24 a Spanish bunch type variety derived from TGE-2 x TGE-1 (Patil *et al.*, 1995) is a popular high yielding cultivar which matures early with high harvest index, better partitioning coefficient and field tolerance to bud necrosis diseases it contains 29 per cent protein, 45 per cent oil, low O/L ratio (Table 1). TGS-2 was derived from TG-187A x M-13 and TGE-1 from TG-9 x Tall, where TG-18A, TG-9 and Tall are either mutants or mutant derivatives traced to Spanish improved.

GPBD 4 (D-39d) is an improved Spanish bunch groundnut variety derived from KRG-1 x CS16 (ICGV-86855) developed at University of Agricultural Sciences, Dharwad (Gowda *et al.*, 2002). GPBD 4 is a second cycle product of inter specific hybridization with desirable combination of medium maturity, high yield resistant to leaf spot and rust diseases, desirable pod and kernel features. Besides these, it has high oil content, better O/L ratio and better protein content (Table 1).

Table 1: Preliminary evaluation of parental lines

Variety	Oil content (%)	Protein (%)	O/L ratio
GPBD 4	50.04	33.17	1.90
TAG 24	45.03	29.04	1.06

3.1.2 Development of mapping population

The mapping population was developed at the University of Agricultural Sciences, Dharwad from the cross TAG 24 x GPBD 4. F_1 s were selfed to produce F_2 and advanced through Single Seed Descent (SSD) method till F_6 generation. Each F_6 line epitomizes the individual F_2 plant from which it is derived (Plate 1).

3.2 Experimental site and climatic condition

Experimental material was evaluated at Botany Garden, Department of Genetics and Plant Breeding, UAS, Dharwad, during summer and *kharif* 2010-11. The soil type of the experimental block of UAS, Dharwad was vertisol with pH in the range of 7.0 to 7.5. Dharwad is located in the transitional tract of Karnataka at 15^o13' north Latitude, 75^o07' east longitude and at an altitude of 678 m above mean sea level with an average rainfall of 800 mm.

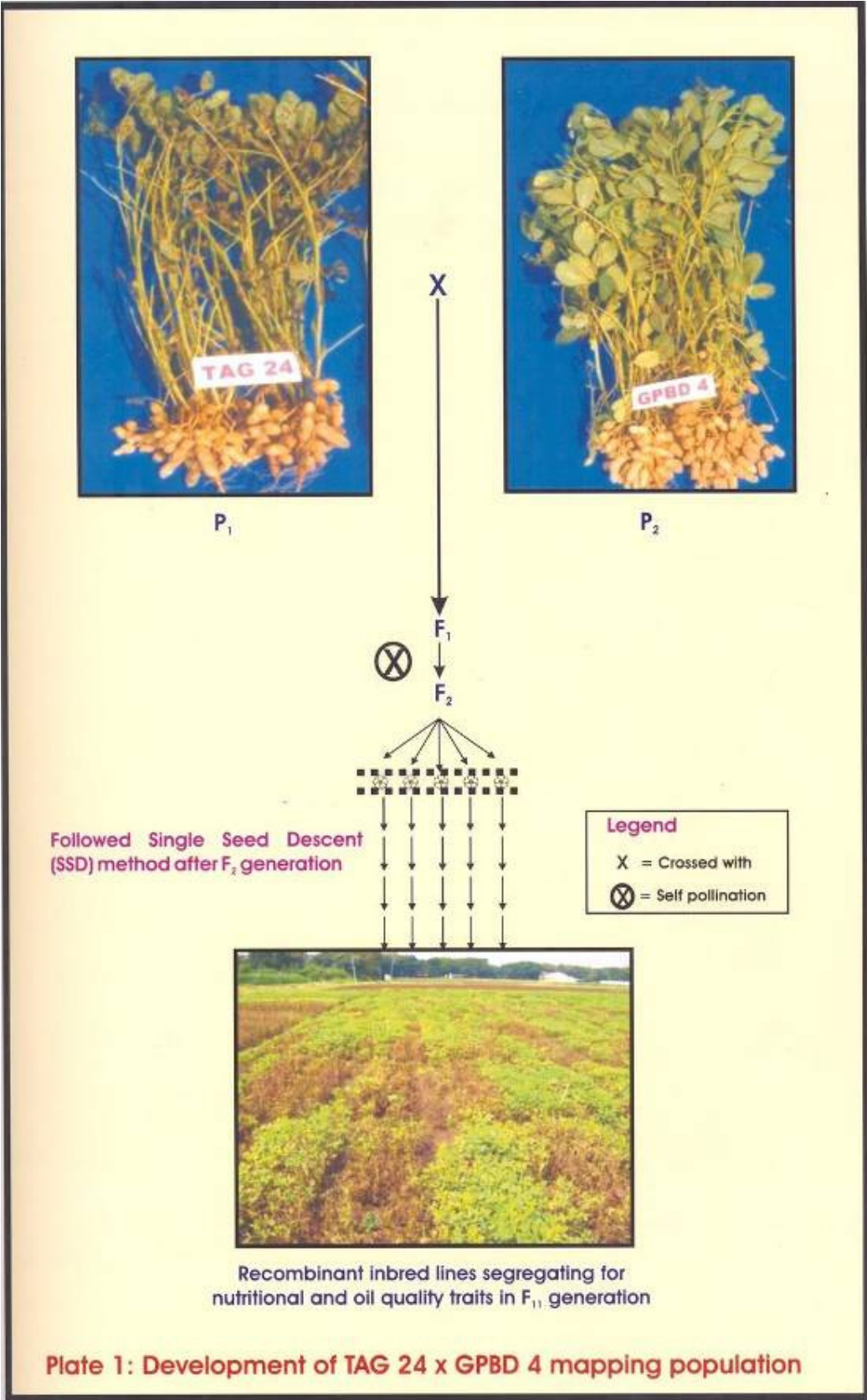


Plate 1: Development of TAG 24 x GPBD 4 mapping population

3.3 Cultivation practices

The seed bed was prepared to the fine tilth before taking up the sowing. The recommended package of practices for cultivation of groundnut crop was adopted.

3.4 Environmental seasons

The monthly meteorological data obtained from Meteorological department of Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, with regard to temperature, relative humidity, rainfall and number of rainy days during the course of investigation is presented in Appendix 1.

3.5 Observations recorded

1. Days to 50% flowering
2. Per cent of germination
3. Kernel yield per plant (g/plant)
4. Intensity of dormancy
5. Duration of dormancy
6. Dry pod yield per plant (g/plant)
7. Shelling per cent (%)
8. 100 kernel weight (g)
9. Sound mature kernel per cent
10. Oil content (%)
11. Protein content (%)
12. Scoring for late leaf spot and rust
13. Scoring for *Spodoptera litura* L.

3.5.1 Days to 50 per cent flowering

Out of the total population when 50 per cent of plants flowered after sowing was recorded as days to 50 per cent flowering.

3.5.2 Per cent of germination

Germination test was conducted by drawing 25 mature seeds random from parents and 10 from each line at 15 days after harvest (DAH) and were rolled in 15 x 12 cm sized germination paper and stapled at both the ends. Each roll was labeled appropriately. These rolls were then arranged in a polythene sheet and rolled over to ensure minimum loss of water through evaporation. These were then transferred to germination chamber and per cent germination was recorded after seven days.

3.5.3 Kernel yield per plant (g)

Kernel yield per plant (g) was calculated based on multiplication of dry pod yield and shelling per cent divided by 100.

$$\text{Kernel yield/plant (g/plant)} = \frac{\text{Dry pod yield per plant} \times \text{shelling (\%)}}{100}$$

3.5.4 Intensity of dormancy

Intensity of dormancy was measured as percentage of non-germinated seeds at 7 days after harvest.

3.5.5 Duration of dormancy

Number of days taken from the day of harvest to achieve full germinability. This was estimated by probit analysis (Wardlaw, 1985).

3.5.5.1 Estimation of G70

The number of days taken for 70 per cent germination (G 70) by each of the lines and parents was estimated by 'probit method' (Wardlaw, 1985). The steps are explained.

3.5.5.2 Graphical approach

The curve obtained for the germination test date when the proportion of seeds germinated is plotted against number of days. This curve is transformed into a straight line by expressing each proportion as a percentage and converting this in turn into a probit value consulting. The plot of probit of germination against number of days is drawn by plotting in the figure.

After plotting the probit values, a straight line is fitted through the points by eye. G 70 is read directly as the day corresponding to a probit of 7.0 (equivalent to 70%).

3.5.6 Sound mature kernels per cent

Well developed and shriveled kernels were separated, counted and percentage was computed as

$$\text{SMK (\%)} = \frac{\text{Number of well developed kernels}}{\text{Total number of kernels}} \times 100$$

3.5.7 Dry pod yield (g/ plant)

Pod yield per plant was calculated by dividing total pod yield per plot by number of plants in the plot, expressed as g/plant.

$$\text{Dry pod yield per plant (g)} = \frac{\text{Dry pod yield per plot (g)}}{\text{Number of plants per plot}}$$

3.5.8 Shelling per cent

Hundred grams of dry pods were taken and shelled. The weight of kernels gave shelling per cent.

$$\text{Shelling per cent} = \frac{\text{Weight of kernels (g)}}{\text{Weight of dry pods (g)}} \times 100$$

3.5.9 Test weight (g)

The well dried and cleaned pods from each genotype were shelled and 100 kernels at random were counted and weight was recorded in grams.

3.5.10 Oil content (%)

Oil content of each RIL for both the seasons was estimated by near infrared spectroscopy (NIRS).

3.5.11 Protein content (%)

Protein content of each RIL for both the seasons was estimated by near infrared spectroscopy (NIRS) at the seed quality testing lab of UAS, Dharwad.

3.5.12 Disease resistance

3.5.12.1 Rust and late leaf spot

The modified 9 point scale for rust (Table 3 and Fig. 1) and late leaf spot (Table 4 and Fig. 2) diseases as given by Subbarao *et al.* (1990) were used for screening genotypes. The visual scores (1-9) and extent of leaf area destroyed (1-100%) are linearly related. The field disease scores are mainly based on the extent of leaf area damaged. For late leaf spot, the extent of defoliation is also incorporated into the scale. Genotypes were scored to 80 (Stage I) and 90 (Stage II) days after sowing for both rust and late leaf spot.

3.6 Statistical analysis

The data collected on the mean of five randomly selected plants per plot of each genotype at each replication was used to calculate mean, range, genetic parameters.

The chi square (χ^2) test was calculated to examine the goodness of fit between the observed and the expected ratios in RILs populations at the probability $p = 0.05$ level of significance.

3.6.1 Mean and range

The mean and range of each character were calculated for each trait.

Mean: it is a measure of central tendency. The arithmetic average of the number of observations.

$$\text{Mean} = \frac{\sum X_i}{n}$$

Where,

$\sum X$ = sum of all observation

n = Number of observation

Range : It was simple measure of variability. The difference between the maximum and minimum value observed for each trait.

3.6.2 Analysis of variance (ANOVA)

The mean data were statistically analysed by split plot analysis for the experiment-I. The critical differences were calculated at five per cent level of probability wherever F test was significant.

The data on different characters for experiment-II were subjected to analysis of variance for Randomized Complete Block Design (RCBD) as detailed by Panse and Sukhatme (1967).

3.6.3 Analysis of variance pooled over seasons

Source of variation	D.f.	M.S.S.	Expected mean square	'F'
Replication in environment	$s(r-1)$	-	-	-
Season (S)	$(s-1)$	M_1	$\sigma_s^2 + \gamma\sigma^2gs + \gamma g\sigma^2s$	M_1M_3
Genotypic (G)	$(g-1)$	M_2	$\sigma_g^2 + \gamma\sigma^2gs + \gamma s\sigma^2g$	M_2M_3
G × S	$(g-1)(s-1)$	M_3	$\sigma_s^2 + \gamma\sigma^2gs$	M_3M_4
Pooled error	$s(r-1)(g-1)$	M_4	σ_s^2	M_3M_4

Where,

- r = Number of replications
- g = Number of genotypes
- s = Number of seasons
- σ_s^2 = Error variance
- σ_g^2 = Genotypic variance
- σ_{gs}^2 = Genotypic-environmental interaction variance

For the combined analysis over seasons, a pooled error mean squares was calculated by pooling the error mean squares of each individual experiment with the help of the following formula.

$$\text{Pooled error mean squares} = \frac{\sum \text{EMS}}{e}$$

Where,

- e = Number of seasons

$$\text{Coefficient of variation (CV \%)} = \frac{\sqrt{\text{EMSS}}}{\bar{X}} \times 100$$

Critical difference (CD) = S. E_d x t at 0.05 for (r-1) (g-1) df

Phenotypic and genotypic variances

These were calculated according to the formula given by Lush (1940) and Choudhary and Prasad (1968).

- Genotypic variance $\sigma^2_g = (\text{GMSS} - \text{EMSS})/r$
- Phenotypic variance $\sigma^2_p = \sigma^2_g + \sigma^2_e$
- Error variance $\sigma^2_e = \text{EMSS}$

Coefficient of variance

The components of variance viz., phenotypic and genotypic variance were used for the estimation of phenotypic and genotypic coefficient of variation as per ha methods suggested by Singh and Choudhary (1979).

$$\text{Phenotypic coefficient of variation (PCV \%)} = \frac{\sqrt{\sigma^2_p}}{\bar{X}} \times 100$$

$$\text{Genotypic coefficient of variation (GCV \%)} = \frac{\sqrt{\sigma^2_g}}{\bar{X}} \times 100$$

Where,

- σ^2_p = Phenotypic variance
- σ^2_g = Genotypic variance
- X = Mean of the character

The GCV and PCV values were classified as described by Sivasubramanian and Menon (1973).

GCV and PCV values	Classification
0 – 10	Low
10 – 20	Medium
20 and above	High

Heritability

Heritability in broad sense (h^2) was computed as a ratio of genotypic variance to the total variance Hanson *et al.*, 1956).

$$h^2 = \frac{\sigma^2g}{\sigma^2p} \times 100$$

Where,

σ^2g = Genotypic variance

σ^2p = Phenotypic variance

Heritability estimates were classified into low, moderate and high by following Hanson *et al.* (1956).

Heritability (%)	Classification
0 – 30	Low
30 – 60	Medium
60 and above	High

Genetic advance

Genetic advance was estimated by using the formula given by Johnson *et al.* (1955).

$$GA = h^2 \times k \times \sigma$$

Where,

h^2 = Heritability estimate

k = Selection differential which is equal to 2.06 at 5% intensity of selection (Lush, 1940)

σ = Phenotypic standard deviation

Genetic advance percentage over mean

$$GAM = \frac{GA}{\bar{X}} \times 100$$

Where,

\bar{GA} = Genetic advance

\bar{X} = General mean of the character

Classification of GAM is as follows (Johnson *et al.*, 1955).

GAM	Classification
0 – 10	Low
10 – 20	Medium
20 and above	High

Table 2: Modified 9-point scale used for field screening groundnut genotypes for resistance to rust diseases

Disease score	Description	Disease severity (%)
1	No disease	0
2	Pustules sparsely distributed, largely on lower leaves	1-5
3	Many pustules on lower leaves, necrosis evident, very few pustules on middle leaves	6-10
4	Number of pustules on lower and middle leaves, severe necrosis of lower leaves	11-20
5	Severe necrosis of lower and middle leaves, pustules may be present on top leaves but less severe	21-30
6	Extensive damage to lower leaves, middle leaves, necrotic with dense distribution of pustules on top leaves	31-40
7	Severe damage of lower and middle leaves, pustules densely distributed on top leaves	41-60
8	100 per cent damage to lower and middle leaves, pustules on top leaves	61-80
9	Almost all leaves withered, bare stems seen	81-100

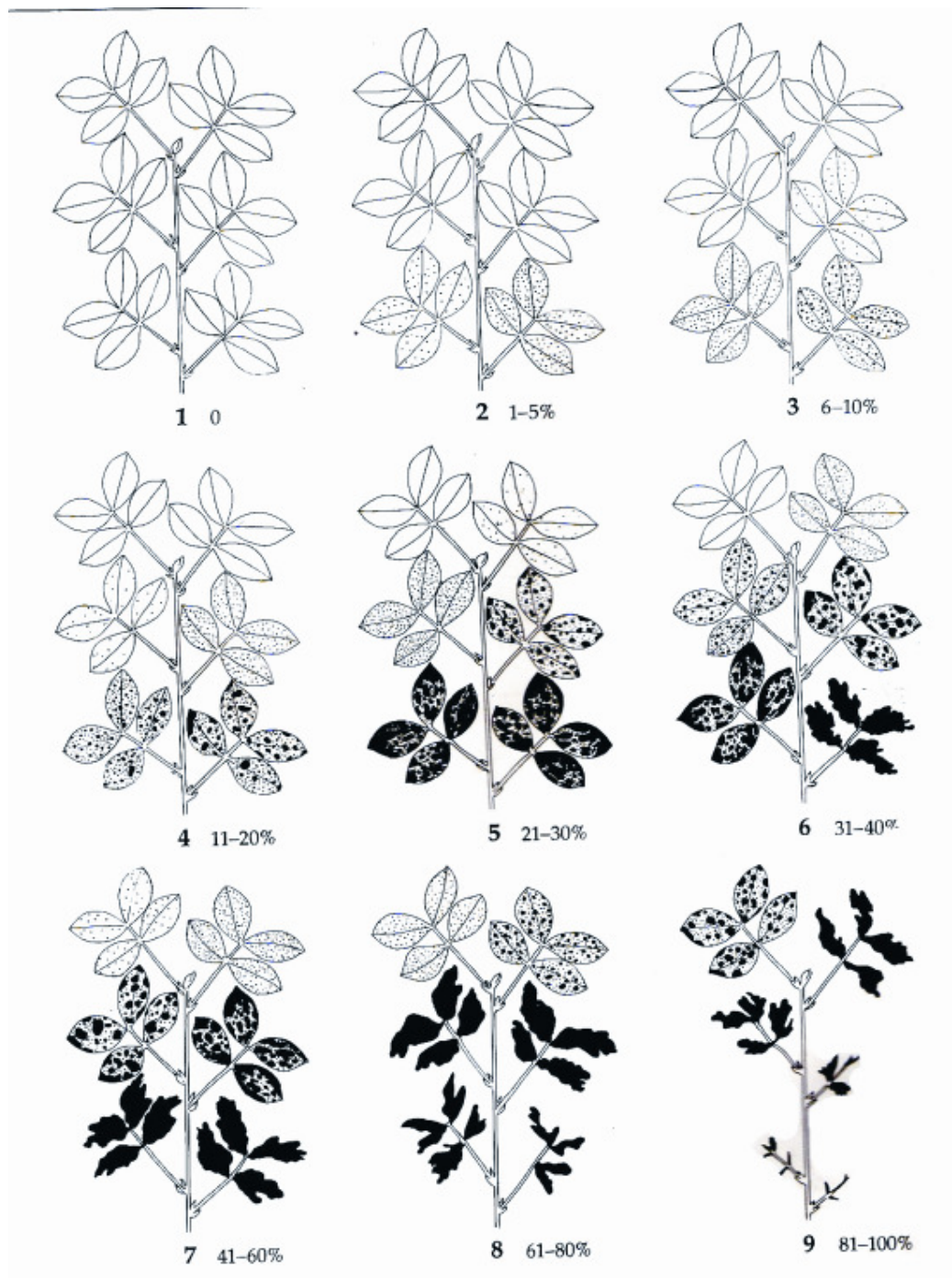


Fig. 1: The modified 9-point scale for field evaluation of rust of groundnut

Table 3: Modified 9-point scale used for field screening groundnut genotypes for resistance to late leaf spot disease

Disease score	Description	Disease severity (%)
1	No disease	0
2	Lesions present largely on lower leaves, no defoliation	1-5
3	Lesions present largely on lower leaves, very few on middle leaves; defoliation of some leaflets evident on lower leaves	6-10
4	Lesions present on lower and middle leaves but severe on lower leaves, defoliation of some leaf lets evident on lower leaves	11-20
5	Lesions present on lower and middle leaves, over 50 % of defoliation of lower leaves	21-30
6	Severe lesions on lower and middle leaves; lesions present but less severe on top leaves; extensive defoliation of lower leaves; some defoliation on middle leaves	31-40
7	Lesions on all leaves but less severe on top leaves; defoliation of all lower and middle leaves	41-60
8	Defoliation of all lower and middle leaves; severe lesions on top leaves evident	61-80
9	Almost all leaves defoliated, leaving bare stem; some leaflets may remain, but show severe leaf spot	81-100

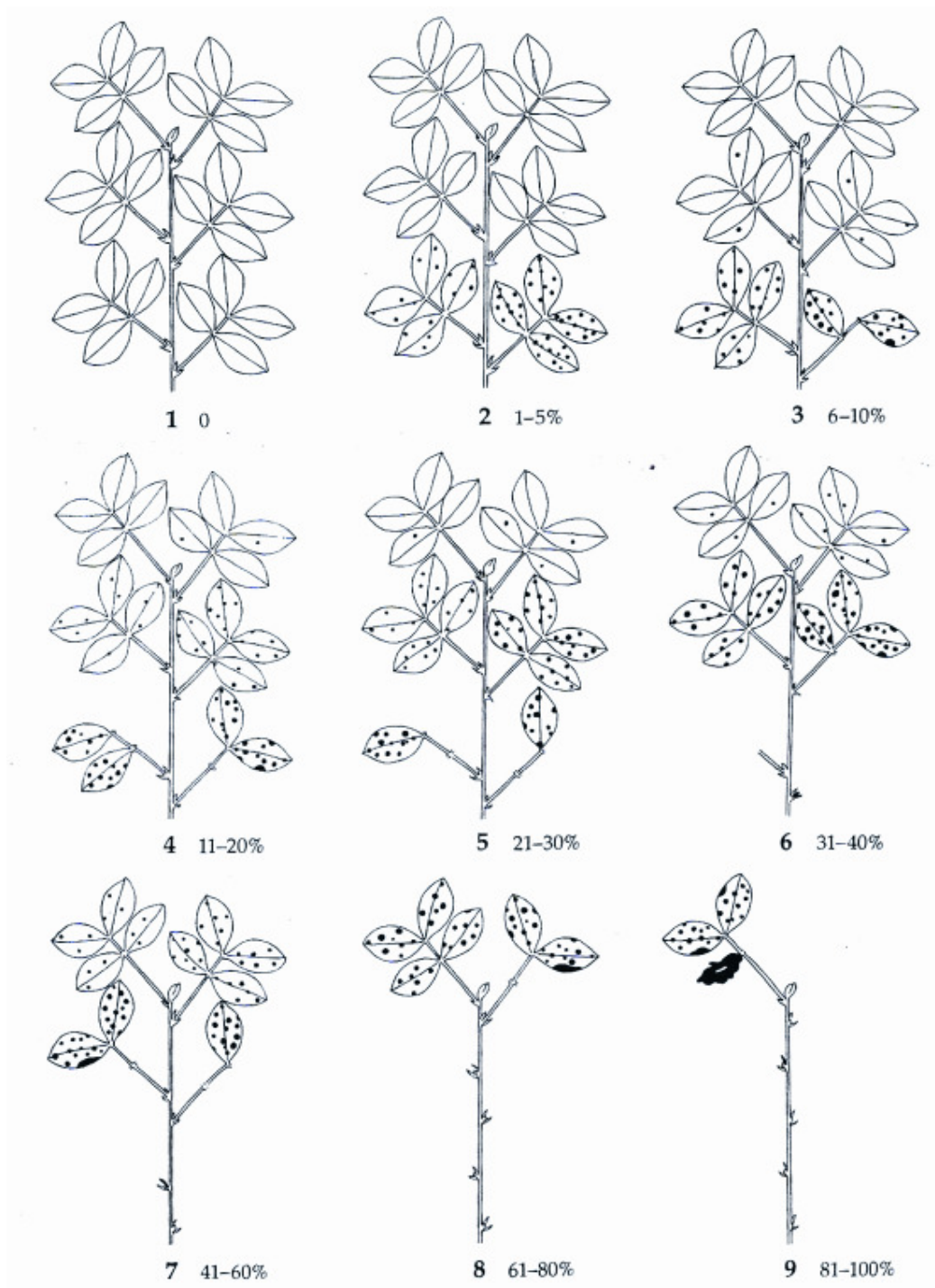


Fig.2: The modified 9-point scale for field evaluation of late leaf spot of groundnut

4. EXPERIMENTAL RESULTS

The results obtained for phenotyping of recombinant inbred population (TAG 24 x GPBD 4), for diseases (rust and LLS) nutritional quality traits (protein and oil) and productivity traits and dormancy in two seasons (summer and *kharif*, 2010) are presented in this chapter.

The Experimental results of the present investigation are presented under following headings.

- 4.1 Phenotypic data analysis of RILs population
 - 4.1.1 Genetic variability for agronomic and productivity traits in RILs population
 - 4.1.2 Genetic variability for protein and oil content traits in RILs population
 - 4.1.3 Genetic variability for disease resistance to LLS and Rust in RILs population
 - 4.1.4 Genetic variability for intensity and duration of dormancy in RILs population
- 4.2 Dormancy analysis of RILs population
 - 4.2.1 Dormancy of RILs population during summer 2010
 - 4.2.2 Dormancy of RILs population during *kharif* 2010
 - 4.2.3 Intensity and Duration of dormancy of RILs population
 - 4.2.4 Nature of dormancy
- 4.3 Frequency of desirable segregants

4.1 Phenotypic data analysis

4.1.1 Genetic variability for agronomic and productivity traits in RIL population

4.1.1.1 Analysis of variance (ANOVA)

Two seasons data of RILs population (TAG 24 x GPBD 4) grown at UAS, Dharwad and the pooled analysis were carried out and ANOVA of yield and yield component traits are presented in Table 4.

Recombinant inbred lines of the mapping population (TAG 24 x GPBD 4) differed significantly from each other for all the traits studied in both seasons and across season while, sound mature kernel differed non-significantly during *kharif* season. These genotypes had significant interaction with environment for kernel yield per plant and shelling percentage but for dry pod yield per plant at 5 per cent only and non-significant for days to 50% flowering, sound mature kernel and hundred kernel weight. Season had shown significant effect on all the traits studied.

4.1.1.2 Mean, range and components of variation

The nature and magnitude of variation for individual trait was assessed by phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance as per cent mean (GAM) and are explained below along with their mean and range (Table 5).

Low GCV (3.70, 2.28 and 3.32), PCV (4.76, 5.42 and 5.53) and GAM (7.59, 2.54 and 5.27.) were recorded for days to 50 per cent flowering in summer, *kharif* season and across the seasons respectively. However, high heritability (60.30) was recorded for the same trait when RILs are grown in summer. Where as in *kharif*, across the seasons low (17.80) and moderate (36.10) heritability was found with mean of 37.59, 30.30 and 33.95 days to 50 per cent of flowering in summer, *kharif* and across the two seasons, respectively The range for days to 50 per cent flowering was less in *kharif* (29.50 to 31 days), compared to summer (35.50 to 41 days).

Table 4: ANOVA for yield components traits and dormancy among RILs of TAG 24 x GPBD 4 mapping population

Sources of variation	Location/season	df	DFF	SP (%)	HKW (g)	KY (g/plant)	DPY (g/ plant)	SMK (%)	Intensity of dormancy	Duration of dormancy
Replication	Summer	1	5.44	0.26	227.13	0.16	0.06	1316.30	230.75	8.66
	<i>Kharif</i>		1.52	93.08	307.51	20.53	14.13	511.37	84.80	2.61
	Pooled		6.36	931.73	267.32	10.34	7.0982	913.84	157.78	5.63
Genotype	Summer	269	4.12**	171.88**	56.31**	10.42**	20.15**	145.21*	709.32 **	44.05**
	<i>Kharif</i>		3.61**	93.40**	59.75**	18.26**	27.40**	43.44	726.82 **	48.19**
	Pooled		6.93**	146.25**	75.68	20.13**	33.68**	94.37*	1211.61**	57.37**
Season	Pooled	1	14322.68**	17811.34**	9625.44**	6097.24**	6683.54**	36073.62**	7456.00**	0.005
G x E interaction	Pooled	1	0.58	2699.68**	40.38	8.55**	13.87*	94.29	224.53**	34.87**
Error	Summer	269	2.02	22.25	37.00	1.71	3.03	118.88	0.45	0.053
	<i>Kharif</i>		2.52	56.48	20.05	3.92	3.71	37.91	0.47	0.09
	Pooled	538	2.13	39.37	28.52	2.82	3.37	78.40	0.46	0.071

* - Significant at 5% level probability

** - Significant at 1% level probability

Note : df – Degrees of freedom

DFF – Days to Fifty per cent flowering

SP (%) – Shelling per cent

HKW(g) – Hundred kernel weight (g)

KY (g/plant) – Kernel yield (g/plant)

DPY (g/plant) – Dry pod yield (g/plant)

Pooled = Across season

Genetic variation for sound mature kernels in each season and across season was low as indicated by low GCV (4.29, 1.73, 1.80), PCV (10.07, 4.85, 5.37) low heritability (18.13, 12.73, 11.31) and low GAM (3.76, 1.27, 1.25) were recorded in each season and across the seasons respectively. Wide range *viz.*, 74.78 to 100.00, 42.01 to 98.80 for this trait was observed in *kharif* and *summer* season with high mean (96.09) in *kharif* when compared to summer (84.53) respectively.

For hundred kernel weight, low GCV (7.80, 9.72 and 7.22) and moderate PCV (17.14, 13.79 and 9.63) in each season and across the seasons were estimated. For the same trait low heritability (20.69) and GAM (5.56) was recorded in summer whereas, it was moderate heritability (49.73 and 56.12) and GAM (16.33 and 11.14) in *kharif* and across the seasons respectively. There was a much variation between the seasons in terms of 100 kernel mean weight. The mean kernel weight was 40.00g in summer 45.64 g in *kharif* and 42.91 g in across the seasons. Wide range (22.00 – 57.00 g) was observed in summer and range was comparatively high in *kharif* (33 – 67.75 g).

RILs had moderate GCV (13.47) for shelling percentage in summer and low GCV (5.94 and 5.33) in *kharif* and across the season but moderate PCV (15.35, 11.97), was recorded in each season and across the season it was low (7.58). Heritability was high (77.06 and 53.25) in summer and across seasons but moderate (24.63) in *kharif*. On the other hand, moderate GAM (18.45) was estimated in summer whereas in *kharif* (5.35) and across the season (8.31) it was low. But shelling per cent was not affected much with two seasons and across the season with mean (65.22, 72.44 and 68.83) but range for this trait also differed in both seasons *viz.*, 52.00 to 90.00 per cent during *kharif* and 35.61 to 78.25 per cent during summer season.

For kernel yield, moderate GCV (20.49, 17.92 and 15.62), high PCV (22.42, 22.23) were recorded in both the seasons and across the season it was moderate (17.86). High heritability (83.52, 78.48 and 76.50) and GAM (38.59, 32.71 and 28.16) was estimated in *kharif*, summer and across the seasons. On the other hand, variation was observed for mean kernel yield (14.93 g, 10.18 g and 12.56 g) during *kharif*, summer and across the seasons, range was high (4.50 to 23.54 g) in *kharif* when compared to summer (4.06 to 15.66 g) respectively.

Moderate GCV (18.71, 16.7 and 14.28) coupled with moderate PCV (20.30, 17.96 and 16.01) were estimated for dry pod yield in each season, and across the seasons. On the other hand high heritability (84.93, 86.44 and 79.59) and high GAM (35.52, 31.98 and 26.25) was recorded for dry pod yield in each season and across the seasons. Mean dry pod yield was high (20.6 g) in *kharif* season compared to summer (15.63 g). Wide range (8.90 to 23.50 g) for this trait was observed in summer season, when compared to *kharif* season (10.99 to 31.31g).

4.1.2 Genetic variability for protein and oil content traits of RILs population

Data on RILs population grown at UAS, Dharwad in *kharif* season was analyzed statistically. Analysis of variance for protein and oil content are presented in Table 6 and Table 7.

RILs recorded significant analysis of variance for both protein and oil content during *kharif* season at both 1 and 5 per cent significance level (Table 6). Among the RILs there was low GCV (6.41) and PCV (7.80) for protein content, but high heritability (67.00) and moderate GAM (11.87) was recorded (Table 7). Low genotypic (2.99) and phenotypic (4.11) coefficients of variation were recorded for oil content also and low GAM (5.11) for this trait. Moderate heritability (52.00) was observed for this trait. The mean oil content (47.21%) and protein content (28.24%) and range was 42.87 to 51.67 for oil content and 22.1 to 36.95 for protein content.

Table 5: Mean, range and estimates of genotypic and phenotypic coefficient of variability, heritability and genetic advance in RILs population over two seasons (summer and *kharif*)

Parameters	Location/ season	DFF	SP (%)	HKW (g)	KY (g/ plant)	DPY (g/per plant)	SMK	Intensity of dormancy	Duration of dormancy
Mean	Summer	37.59	65.22	40	10.18	15.63	84.53	16.80	6.18
	<i>Kharif</i>	30.3	72.44	45.81	14.93	20.6	96.09	11.55	6.08
	Pooled	33.95	68.83	42.91	12.56	18.12	90.32	14.18	14.03
Range	Summer	35.50-41.00	35.61-78.25	22.00-57.00	4.06-15.66	8.90-23.50	42.01-98.80	0.00-90.05	2.84-38.20
	<i>Kharif</i>	29.50-31.00	52.00-90.00	33.00-67.75	4.50-23.54	10.99-31.31	74.78-100.00	0.00-76.75	3.43-37.84
	Pooled	32.75-36.00	52.00-82.00	30.12-55.00	6.55-18.51	10.34-24.59	68.54-98.58	0.00-90.00	3.43-32.68
GCV (%)	Summer	3.70	13.47	7.80	20.49	18.71	4.29	111.09*	76.6
	<i>Kharif</i>	2.28	5.94	9.72	17.92	16.7	1.73	164.80*	80.50
	Pooled	3.32	5.53	7.22	15.62	14.28	1.80	118.89*	73.8
PCV (%)	Summer	4.76	15.35	17.14	22.42	20.30	10.07	112.20*	77.50
	<i>Kharif</i>	5.42	11.97	13.79	22.23	17.96	4.85	165.10*	80.68
	Pooled	5.53	7.58	9.63	17.86	16.01	5.37	122.76*	71.28
h ² (broad Sense)	Summer	60.30	77.06	20.69	83.52	84.93	18.13	75.00*	76.00
	<i>Kharif</i>	17.80	24.63	49.73	78.48	86.44	12.73	80.00*	78.00
	Pooled	36.10	53.25	56.12	76.50	79.59	11.31	93.00*	95.00
GAM	Summer	7.59	18.45	5.56	38.59	35.52	3.76	29.12*	9.78
	<i>Kharif</i>	2.54	5.35	16.33	32.71	31.98	1.27	31.42*	7.88
	Pooled	5.27	8.31	11.14	28.16	26.25	1.25	33.62*	7.63

Note : df – Degrees of freedom
 HKW(g) – Hundred kernel weight (g)
 Pooled = Across season

DFF – Days to Fifty per cent flowering
 KY (g/plant) – Kernel yield (g/plant)
 * - Indicates transformed values

SP (%) – Shelling per cent
 DPY (g/plant) – Dry pod yield (g/plant)

4.1.3 Genetic variability for disease resistance (Rust and LLS) traits of RILs population

4.1.3.1 Analysis of variance (ANOVA)

Two seasons data of RILs population grown at UAS, Dharwad and the pooled analysis were carried out and ANOVA for rust and LLS at different stages of crop growth are presented in Table 8.

Recombinant inbred lines of the mapping population differed significantly for rust and LLS at 70, 80 and 90 DAS both during summer and *kharif* season. Whereas, RILs differed significantly for LLS at all stages but it differed non-significantly for rust across season. These genotypes had non-significant interact with in environment for rust at all stages and for LLS at 70 DAS but shows significant G x E interaction for LLS at 80 and 90 DAS. Whereas, season had showed significant effect on both the traits at all the stages studied.

4.1.3.2 Mean, range and components of variation

The nature and magnitude of variation for individual trait was assessed by phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance as per cent mean (GAM) and are explained below along with their mean and range (Table 9).

For rust, low GCV (4.31, 5.61 and 8.66) (8.38 and 9.09) (6.26 and 7.60) was observed during summer, *kharif* and across season at 70, 80, 90 DAS. where as moderate GCV (19.95 and 15.10) was observed at 90 DAS in *kharif* and across season. Moderate PCV (10.19, 11.14 and 16.39) (11.12 and 13.71) (10.17, 10.57 and 18.14) was recorded in each season and across season at 70, 80, 90 DAS and high PCV (23.23) was recorded at 90 DAS in *kharif*. However, moderate heritability (23.41, 25.37 and 27.95) (56.79 and 44.03) (59.02 and 51.72) was recorded in each season and across seasons but high heritability (73.81 and 69.33) was observed at 90DAS in *kharif* and across seasons. Genetic advance as per cent mean was found to be low (5.11, 5.82 and 9.43) in summer at 70, 80, 90 DAS. Where as it was moderate (13.01 and 12.43) in *kharif* at 70, 80 DAS and high (35.32) at 90 DAS. On the other hand high GAM (25.73 and 25.91) was recorded at 70 and 90 DAS across seasons. There was a much variation between the seasons in terms of mean score for rust at all the stages. Wide range (0.00 to 4.50, 0.00to4.00 and 3.00 to 6.50) at 70, 80 and 90 DAS respectively was observed in *kharif* and range was comparatively less in summer (0.00 to 3.00, 0.00 to 3.50 and 0.00 to 4.00) at 70, 80 and 90 DAS respectively.

For LLS, low GCV (4.63, 8.05 and 9.95) was observed during summer at 70, 80 and 90 DAS while during *kharif* and across the season low GCV (8.17 and 6.86) was recorded at 70 DAS. But moderate GCV (14.73 and 23.66) (11.30 and 17.28) was observed at 80 and 90 DAS respectively. On the other hand moderate PCV (10.49, 14.17 and 18.42) (11.35, 16.78 and 25.32) (10.61, 13.55 and 20.07) was recorded in each season and across seasons at 70, 80 and 90 DAS respectively. The heritability was found to be moderate (26.81, 32.31 and 29.20) in summer but in *kharif* and across season it was found high (51.84, 77.11 and 87.29) and (69.13, 69.54 and 74.13) at 70, 80 and 90 DAS respectively. Here genetic advance as per cent mean was found to be low (6.37, 9.43 and 11.08) during summer but it was estimated to be high (12.12 26.65 and 45.54) and (28.87, 19.42 and 30.66) in *kharif* and across the seasons at all stages respectively, There was a much variation between the seasons in terms of mean score for LLS at all the stages. Wide range (3.00 to 6.50, 3.00 to 8.50 and 3.00 to 9.00) at 70, 80 and 90 DAS respectively was observed in *kharif* and range was comparatively less in summer (0.00 to 4.50, 2.00 to 6.00 and 2.00 to 6.00) at 70, 80 and 90 DAS respectively.

4.1.4 Genetic variability for intensity and duration of dormancy in RILs population

Recombinant inbred lines of the mapping population differed significantly for intensity and duration of dormancy during summer, *kharif* and across seasons. RILs have significant interaction with environment for both the traits. Season had shown significant effect with intensity of dormancy but it shown non-significant with duration of dormancy as presented in Table 4 and 5.

Table 6: ANOVA for protein and oil content among RILs of TAG 24 x GPBD 4 mapping population during *kharif* season

Source of variation	df	Protein (%)	Oil (%)
Replication	1	1064.01	52.30
Genotypes	269	8.14**	5.77**
Error	269	1.57	1.78

* - Significant at 5% level probability

** - Significant at 1% level probability

Table 7: Component of variation for protein and oil content among RILs of TAG 24 x GPBD 4 mapping population during *kharif* season

Parameters	Protein (%)	Oil (%)
Mean	28.24	47.21
Range	22.10 – 36.95	42.87 – 51.67
GCV (%)	6.41	2.99
PCV (%)	7.80	4.11
h ² (broad Sense)	67.0	52.0
GAM	11.87	5.11

Table 8: ANOVA for disease component traits among RILs of TAG 24 x GPBD 4 mapping population

Sources of variation	Location/ season	df	Rust			LLS		
			70 DAS	80 DAS	90 DAS	70 DAS	80 DAS	90 DAS
Replication	Summer	1	0.09	0.02	3.11	2.14	8.31	30.34
	<i>Kharif</i>		0.74	0.18	5.60	0.41	22.81	3.75
	Pooled		0.415	0.1074	4.35	1.27	15.56	17.04
Genotype	Summer	269	1.56**	1.50**	0.25**	0.46**	0.81**	1.00**
	<i>Kharif</i>		0.24**	0.26**	0.74**	1.23**	3.45**	4.70**
	Pooled		0.95	1.04	0.65	1.19*	2.99**	3.94**
Season	Pooled	1	745.00**	472.03**	413.17**	455.00**	853.33**	1322.24**
G x E interaction	Pooled	1	0.85	0.71	0.34	0.49	1.27*	1.75**
Error	Summer	269	0.20	0.12	0.19	0.31	0.58	0.70
	<i>Kharif</i>		0.10	0.12	0.41	0.28	0.90	0.59
	Pooled	538	0.15	0.12	0.30	0.29	0.74	0.65

* - Significant at 5% level probability ** - Significant at 1% level probability

Table 9: Mean, range and estimates of genotypic and phenotypic coefficient of variability, heritability and genetic advance in RILS population over two seasons (summer and *kharif*)

Sources of variation	Location/ season	Rust			LLS		
		70 DAS	80 DAS	90 DAS	70 DAS	80 DAS	90 DAS
Mean	Summer	1.47	1.85	3.2	3.38	3.88	3.84
	<i>Kharif</i>	3.13	3.18	4.44	4.68	5.66	6.05
	Pooled	2.30	3.83	4.77	2.52	4.03	4.95
Range	Summer	0.00-3.00	0.00-3.50	0.00-4.00	0.00-4.50	2.00-6.00	2.00-6.00
	<i>Kharif</i>	0.00-4.50	0.00-4.00	3.00-6.50	3.00-6.50	3.00-8.50	3.00-9.00
	Pooled	0.00-3.50	1.50-5.00	2.50-7.00	0.00-3.50	1.50-5.25	2.50-7.00
GCV (%)	Summer	4.31	5.61	8.66	4.63	8.05	9.95
	<i>Kharif</i>	8.38	9.09	19.95	8.17	14.73	23.66
	Pooled	6.26	7.60	15.10	6.86	11.30	17.28
PCV (%)	Summer	10.19	11.14	16.39	10.49	14.17	18.42
	<i>Kharif</i>	11.12	13.71	23.23	11.35	16.78	25.32
	Pooled	10.17	10.57	18.14	10.61	13.55	20.07
h ² (%) (broad Sense)	Summer	23.41	25.37	27.95	26.81	32.31	29.20
	<i>Kharif</i>	56.79	44.03	73.81	51.84	77.11	87.29
	Pooled	59.02	51.72	69.33	69.13	69.54	74.13
GAM	Summer	5.11	5.82	9.43	6.37	9.43	11.08
	<i>Kharif</i>	13.01	12.43	35.32	12.12	26.65	45.54
	Pooled	25.73	11.27	25.91	28.87	19.42	30.66

DAS – Days after sowing

For intensity of dormancy high GCV (111.09, 164.80 and 118.89) and PCV (112.20, 165.10 and 122.76) was observed in each season and across the seasons. Genetic advance as per cent mean (31.42 and 33.62) was estimated to be high in *kharif* and across the seasons, whereas, it was moderate (29.12) in summer. High heritability (75.00, 80.00 and 93.00) was recorded in both seasons and across the seasons. There was a much variation between the seasons in terms of mean intensity of dormancy. The mean intensity of dormancy was 11.55 in *kharif*, 16.80 in summer and 14.18 across the seasons. Wide range of intensity of dormancy (0.00 to 90.05) was observed in summer and range was moderate in *kharif* (0.00 to 76.75).

High GCV (76.6 and 80.50) and PCV (77.50 and 80.68) were estimated for duration of dormancy in each season, whereas, across the seasons both GCV (73.8) and PCV (71.28) were also high. High heritability (76.00 and 78.00) was recorded for duration of dormancy in each season. However, across the seasons (95.00), it was high. The GAM (9.78, 7.88 and 7.63) was high from evaluation in summer, *kharif* season and across the two seasons. Mean duration of dormancy was high (6.18 days) in summer season compared to *kharif* (6.08 days). Wide range (2.84 to 38.20) for this trait was observed in summer season, compared for *kharif* season (3.43 to 37.84 days).

4.2 Dormancy analysis of RILs population

4.2.1 Dormancy of RILs population during summer 2010

In summer, 268 RILs were evaluated for dormancy along with their parents. The results were shown in the Table 10

Analysis of variance with respect to germination percentage of different RILs showed significant differences at all the intervals for germination test starting from seven days after harvest upto 28 days after harvest.

Out of 268 RILS which were put for germination test only 52 lines (5, 11, 23, 40, 46, 48, 72, 79, 80, 84, 89, 90, 91, 98, 103, 104, 106, 110, 111, 114, 127, 130, 135, 158, 160, 165, 172, 176, 183, 195, 196, 202, 209, 213, 214, 216, 217, 220, 222, 230, 242, 245, 247, 248, 254, 255, 257, 259, 265, 266 and 267) recorded 70 and less than 70 per cent germination. Among these lines identified only 16 lines (5, 40, 79, 84, 89, 91, 104, 160, 165, 183, 209, 213, 247, 259, 265 and 267) (Fig. 3), 6 lines (40, 84, 183, 209, 213 and 259) and 5 lines (40, 84, 209, 213 and 259) showed 70 and less than 70 per cent germination at 14, 21 and 28 days after harvest, respectively.

The RILs which exhibited 70 and less than 70 per cent germination at 7 days after harvest. Among them the RILs No. 79, 80, 91, 110, 160, 172, 195, 248 and 254 line recorded less than 35 per cent of germination but at 14 days these RIL lines attained more than 70 per cent germination level and later at 21 days after harvest recorded 100 per cent germination.

Whereas, RILs No. 89 and 165 which recorded less than 5 per cent germination at 7 days after harvest attained 50 per cent germination at 14 days after harvest.

On the other hand the RILs No. 213 and 259 which recorded less than 30 per cent of germination at 7 days after harvest took at least 21 days for attaining 50 per cent of germination level (Fig. 3).

In this season the RILs No. 84, 209, 165 and 89 recorded very low germination percentage (i.e., < 10%) at seventh days after harvest. Among these lines the RIL No. 84 and 209 required 28 days each for attaining 50 and 60 per cent germination level, respectively (Fig. 3).

4.2.2 Dormancy of RILs population during *kharif* 2010

In *kharif*, 268 RILs were evaluated for dormancy along with their parents. The results were shown in the Table 10

Analysis of variance with respect to germination percentage of different RILs showed significant differences at all the intervals for germination test. Starting from seven days after harvest upto 28 days after harvest.

Table 10: Germination percentage mean of groundnut RILs at weekly intervals after harvest during summer and *Kharif* seasons

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
TAG-24	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
GPBD-4	50 (45.02)	85 (67.25)	100 (90.05)	100 (90.05)	85 (67.25)	85 (67.25)	85 (67.25)	100 (90.05)
1	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
2	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
3	80 (63.47)	90 (71.60)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
4	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
5	50 (45.02)	65 (53.76)	80 (63.47)	100 (90.05)	30 (33.23)	35 (36.29)	45 (42.15)	60 (50.79)
6	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
7	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
8	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
9	85 (67.25)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
10	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
11	50 (45.02)	75 (60.03)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
12	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
13	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
14	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
15	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
16	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
17	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
18	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

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Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
19	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
20	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
21	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
22	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
23	60 (50.79)	75 (60.03)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
24	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
25	75 (60.03)	90 (71.60)	100 (90.05)	100 (90.05)	85 (67.25)	85 (67.25)	85 (67.25)	100 (90.05)
26	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
27	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)
28	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
29	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
30	50 (45.02)	75 (60.03)	100 (90.05)	100 (90.05)	30 (33.23)	35 (36.29)	45 (42.15)	60 (50.79)
31	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
32	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
33	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
34	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
35	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
36	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
37	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
38	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
39	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
40	40 (39.25)	45 (42.15)	55 (47.89)	60 (50.79)	25 (30.02)	45 (42.15)	100 (90.05)	100 (90.05)
41	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
42	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
43	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
44	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
45	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
46	70 (56.82)	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
47	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
48	45 (42.15)	95 (77.12)	100 (90.05)	100 (90.05)	35 (36.29)	100 (90.05)	100 (90.05)	100 (90.05)
49	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
50	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
51	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	85 (67.25)	100 (90.05)	85 (67.25)	100 (90.05)
52	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
53	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)
54	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
55	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
56	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
57	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
58	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
59	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
60	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
61	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
62	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
63	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
64	75 (60.03)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
65	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
66	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
67	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
68	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
69	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
70	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
71	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
72	50 (45.02)	100 (90.05)	100 (90.05)	100 (90.05)	45 (42.15)	90 (71.60)	100 (90.05)	100 (90.05)
73	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
74	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
75	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
76	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	35 (36.29)	95 (77.12)	100 (90.05)	100 (90.05)
77	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
78	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
79	25 (30.02)	70 (56.82)	90 (71.60)	100 (90.05)	50 (45.02)	60 (50.79)	80 (63.47)	100 (90.05)
80	30 (33.23)	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)
81	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
82	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
83	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
84	10 (18.44)	25 (30.02)	35 (36.29)	55 (47.89)	35 (36.29)	35 (36.29)	60 (50.79)	90 (71.60)
85	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
86	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
87	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
88	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
89	5 (12.93)	50 (45.02)	100 (90.05)	100 (90.05)	35 (36.29)	100 (90.05)	100 (90.05)	100 (90.05)
90	65 (53.76)	80 (63.47)	100 (90.05)	100 (90.05)	50 (45.02)	70 (56.82)	100 (90.05)	100 (90.05)
91	35 (36.29)	60 (50.79)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
92	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
93	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)
94	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
95	75 (60.03)	100 (90.05)	100 (90.05)	100 (90.05)	55 (47.89)	65 (53.76)	80 (63.47)	100 (90.05)
96	75 (60.03)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
97	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
98	70 (56.82)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
99	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
100	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
101	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)
102	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
103	65 (53.76)	85 (67.25)	100 (90.05)	100 (90.05)	35 (36.29)	35 (36.29)	95 (77.12)	100 (90.05)
104	45 (42.15)	70 (56.82)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
105	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
106	60 (50.79)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
107	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
108	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
109	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
110	20 (26.58)	75 (60.03)	100 (90.05)	100 (90.05)	45 (42.15)	50 (45.02)	80 (63.47)	100 (90.05)
111	50 (45.02)	75 (60.03)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
112	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
113	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
114	65 (53.76)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
115	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
116	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
117	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
118	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
119	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
120	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
121	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
122	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
123	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
124	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
125	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
126	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
127	60 (50.79)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
128	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
129	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
130	55 (47.89)	100 (90.05)	100 (90.05)	100 (90.05)	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)
131	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
132	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
133	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
134	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
135	55 (47.89)	90 (71.60)	100 (90.05)	100 (90.05)	35 (36.29)	95 (77.12)	100 (90.05)	100 (90.05)
136	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
137	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
138	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
139	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
140	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
141	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
142	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
143	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
144	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
145	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
146	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
147	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
148	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
149	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
150	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
151	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
152	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
153	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
154	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
155	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
156	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
157	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
158	70 (56.82)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
159	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
160	25 (30.02)	70 (56.82)	100 (90.05)	100 (90.05)	25 (30.02)	75 (60.03)	100 (90.05)	100 (90.05)
161	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	65 (53.76)	100 (90.05)	100 (90.05)	100 (90.05)
162	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
163	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
164	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
165	0 (0.00)	50 (45.02)	80 (63.47)	100 (90.05)	20 (26.58)	25 (30.02)	90 (71.60)	100 (90.05)

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Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
166	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
167	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
168	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
169	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
170	75 (60.03)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
171	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
172	40 (39.25)	75 (60.03)	75 (60.03)	75 (60.03)	40 (39.25)	100 (90.05)	100 (90.05)	100 (90.05)
173	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
174	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
175	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
176	70 (56.82)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
177	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
178	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
179	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
180	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
181	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
182	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
183	35 (36.29)	40 (39.25)	60 (50.79)	90 (71.60)	45 (42.15)	45 (42.15)	65 (53.76)	100 (90.05)
184	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
185	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
186	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
187	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
188	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	65 (53.76)	100 (90.05)	100 (90.05)	100 (90.05)
189	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
190	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
191	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
192	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
193	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
194	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
195	15 (22.80)	90 (71.60)	100 (90.05)	100 (90.05)	45 (42.15)	90 (71.60)	100 (90.05)	100 (90.05)
196	60 (50.79)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
197	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
198	75 (60.03)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
199	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
200	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
201	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
202	25 (30.02)	80 (63.47)	100 (90.05)	100 (90.05)	35 (36.29)	95 (77.12)	100 (90.05)	100 (90.05)
203	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
204	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
205	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
206	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
207	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
208	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
209	10 (18.44)	30 (33.23)	40 (39.25)	60 (50.79)	10 (18.44)	25 (30.02)	35 (36.29)	100 (90.05)
210	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
211	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
212	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)
213	30 (33.23)	40 (39.25)	55 (47.89)	70 (56.82)	10 (18.44)	45 (42.15)	55 (47.89)	65 (53.76)
214	60 (50.79)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
215	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
216	70 (56.82)	100 (90.05)	100 (90.05)	100 (90.05)	65 (53.76)	70 (56.82)	100 (90.05)	100 (90.05)
217	25 (30.02)	100 (90.05)	100 (90.05)	100 (90.05)	35 (36.29)	95 (77.12)	100 (90.05)	100 (90.05)
218	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
219	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	45 (42.15)	45 (42.15)	100 (90.05)	100 (90.05)
220	50 (45.02)	85 (67.25)	100 (90.05)	100 (90.05)	35 (36.29)	45 (42.15)	95 (77.12)	100 (90.05)
221	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	80 (63.47)	100 (90.05)
222	45 (42.15)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
223	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
224	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
225	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
226	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)
227	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
228	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
229	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
230	70 (56.82)	100 (90.05)	100 (90.05)	100 (90.05)	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)
231	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
232	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	55 (47.89)	80 (63.47)	100 (90.05)	100 (90.05)
233	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
234	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
235	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
236	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	65 (53.76)	100 (90.05)	100 (90.05)	100 (90.05)
237	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)	45 (42.15)	100 (90.05)	100 (90.05)	100 (90.05)
238	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
239	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
240	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
241	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
242	60 (50.79)	100 (90.05)	100 (90.05)	100 (90.05)	50 (45.02)	80 (63.47)	100 (90.05)	100 (90.05)
243	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
244	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
245	60 (50.79)	100 (90.05)	100 (90.05)	100 (90.05)	70 (56.82)	100 (90.05)	100 (90.05)	100 (90.05)
246	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
247	35 (36.29)	65 (53.76)	100 (90.05)	100 (90.05)	30 (33.23)	90 (71.60)	100 (90.05)	100 (90.05)
248	30 (33.23)	75 (60.03)	100 (90.05)	100 (90.05)	30 (33.23)	35 (36.29)	80 (63.47)	100 (90.05)
249	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)

Contd...

Lines	Days after harvest during summer				Days after harvest during kharif			
	7	14	21	28	7	14	21	28
250	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
251	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
252	85 (67.25)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
253	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
254	30 (33.23)	80 (63.47)	100 (90.05)	100 (90.05)	25 (30.02)	50 (45.02)	75 (60.03)	100 (90.05)
255	40 (39.25)	80 (63.47)	100 (90.05)	100 (90.05)	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)
256	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
257	65 (53.76)	90 (71.60)	100 (90.05)	100 (90.05)	10 (18.44)	25 (30.02)	75 (60.03)	100 (90.05)
258	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	95 (77.12)	100 (90.05)	100 (90.05)	100 (90.05)
259	30 (33.23)	45 (42.15)	55 (47.89)	60 (50.79)	20 (26.58)	50 (45.02)	75 (60.03)	100 (90.05)
260	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	70 (56.82)	100 (90.05)	100 (90.05)	100 (90.05)
261	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
262	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
263	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)
264	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)
265	20 (26.58)	70 (56.82)	100 (90.05)	100 (90.05)	35 (36.29)	80 (63.47)	100 (90.05)	100 (90.05)
266	60 (50.79)	90 (71.60)	100 (90.05)	100 (90.05)	50 (45.02)	70 (56.82)	100 (90.05)	100 (90.05)
267	50 (45.02)	60 (50.79)	75 (60.03)	100 (90.05)	10 (18.44)	15 (22.80)	25 (30.02)	50 (45.02)
268	90 (71.60)	100 (90.05)	100 (90.05)	100 (90.05)	80 (63.47)	100 (90.05)	100 (90.05)	100 (90.05)

* Value in parenthesis indicates transformed value

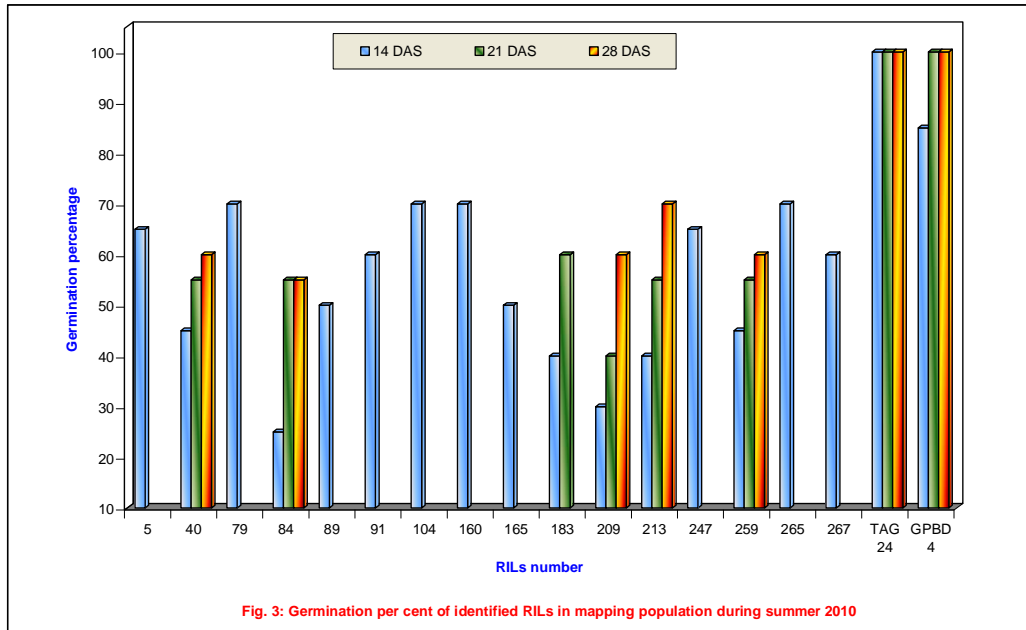


Fig. 3: Germination per cent of identified RILs in mapping population during summer 2010

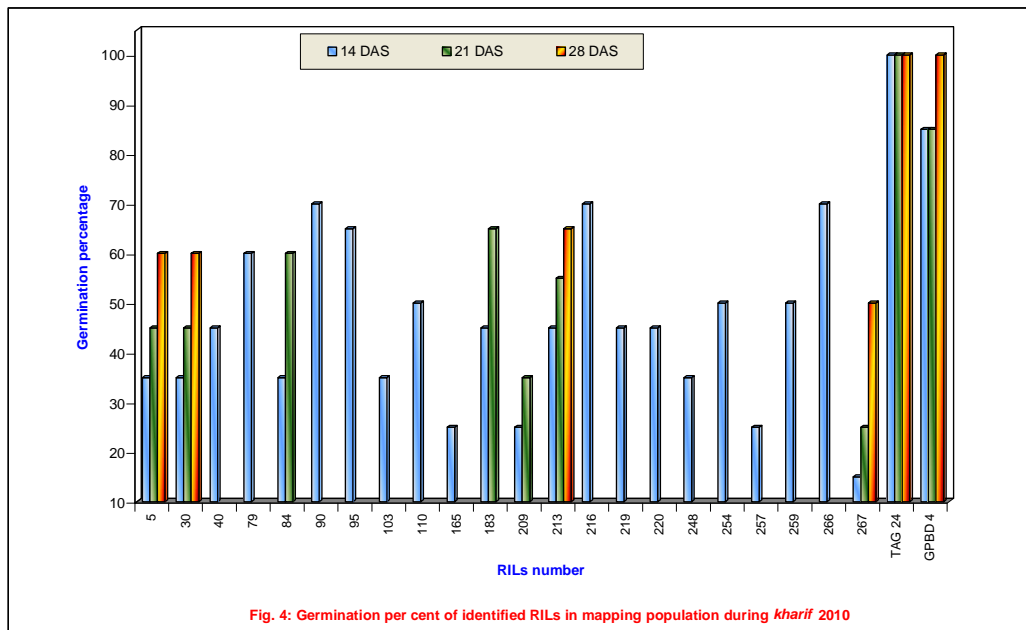


Fig. 4: Germination per cent of identified RILs in mapping population during kharif 2010

Out of 268 RILs which were put for germination test only 41 lines (5, 30, 40, 48, 72, 76, 79, 84, 89, 90, 95, 103, 110, 135, 160, 165, 172, 183, 188, 195, 202, 209, 213, 216, 217, 219, 220, 232, 236, 237, 242, 245, 247, 248, 254, 257, 259, 260, 265, 266 and 267) recorded 70 and less than 70 per cent germination. Among these lines identified only 22 line (5, 30, 40, 79, 84, 90, 95, 103, 110, 165, 183, 209, 213, 216, 219, 220, 248, 254, 257, 259, 266 and 267) (Fig. 4) 7 lines (5, 30, 84, 183, 209, 213 and 267) and 4 lines (5, 30, 213 and 267) showed 70 and less than 70 per cent germination at 14, 21 and 28 days after harvest.

The RILs which exhibited 70 and less than 70 per cent germination at 7 days after harvest. Among them the RIL No. 89, 90, 110, 135, 160, 172, 195, 202, 219, 217, 232, 237, 242, 265 and 266 recorded less than 50 per cent of germination but within 21 days after harvest recorded 100 per cent germination.

Whereas, the RIL No. 40, 84, 103, 165, 183 and 220 recorded less than 35 per cent of germination at 7 days after harvest showed more than 60 per cent germination at 21 days after harvest.

On the other hand the RILs No. 209, 248, 254, 259 has shown less than 30 per cent of germination at seven days after harvest took nearly 21 days for reaching 75 per cent of germination level (Fig. 4).

In this season the RILs No. 209, 213, 257, 259 and 267 recorded very low percentage (< 20%) of germination at 7 days after harvest. Among these lines the RILs No. 267 and 213 required 28 days each for attaining 50 and 65 per cent germination level, respectively. Whereas, the RIL No. 5 and 30 recorded 30 per cent germination at seventh day after harvest required 28 days for attaining 60 per cent germination level (Fig. 4).

4.2.3 Intensity and duration of dormancy of RILs population

In general, the intensity of dormancy and duration of dormancy was higher in *Kharif* than in summer indicating seasonal difference.

The data on the intensity of dormancy on 7th day after harvest over different seasons are presented in Table 11.

The intensity of dormancy was ranged from 0 to 100 per cent during summer and 0 to 90 per cent during *Kharif* season. During summer, high intensity of dormancy was recorded by line no.165 (100%) and lowest was 0 per cent while during *Kharif*, high intensity was noticed by line no.209, 213, 257 and 267 (90%) and least was 0 per cent.

Among parents dormant line GPBD 4 recorded 50 and 15 per cent of intensity during summer and *Kharif*, while TAG 24 recorded 10 and 0 per cent of intensity during summer and *Kharif*, respectively.

Out of 268 lines studied, 7 lines viz., RIL no. 84, 89, 110, 165, 195, 209 and 265 have recorded more than 80 per cent dormancy during summer season (Fig.). While, 6 lines viz., RIL no. 165, 209, 213, 257, 259 and 267 exhibited more than 80 per cent dormancy during *Kharif* season (Fig. 5).

The RIL no. 165 and 209 have recorded more than 80 per cent dormancy both in *Kharif* and summer seasons. As many as 9 lines viz., RIL no. 80, 79, 84, 89, 110, 195, 202, 217 and 265 have recorded low intensity of dormancy less than 70 per cent in *Kharif* but relatively high intensity in summer season.

The RIL no. 89 have recorded 95 per cent dormancy in summer but showed relatively low intensities during *Kharif* (65%). While, RIL no. 257 and 267 has registered high intensity (90%) in *Kharif* but relatively low intensities during summer (30 and 25% respectively)

Among the RILs tested line no. 165, 259, 160, 172, 209, 254, 213, 247, and 248 have high stable intensities of dormancy over seasons. While line no. 84, 89, 110, 195, 257 and 267 have registered high fluctuations in intensity of dormancy during *Kharif* and summer.

The days taken for 70 per cent germination by each dormant RILs has been considered as an indicator for the duration of dormancy for that RILs. The C70 values estimated by probit method for different RILs identified as dormant are presented in the Table 12.

Table 11: Intensity of dormancy as shown by different dormant RILs at seven days after harvest during summer and *kharif* seasons

Lines	Intensity of dormancy		Lines	Intensity of dormancy		Lines	Intensity of dormancy	
	Summer	Kharif		Summer	Kharif		Summer	Kharif
TAG 24	10.00	0.00	33	10.00	5.00	67	20.00	0.00
GPBD 4	50.00	15.00	34	15.00	0.00	68	0.00	0.00
1	0.00	0.00	35	5.00	10.00	69	0.00	0.00
2	5.00	0.00	36	0.00	10.00	70	20.00	0.00
3	20.00	0.00	37	10.00	0.00	71	5.00	0.00
4	0.00	0.00	38	10.00	0.00	72	50.00	55.00
5	50.00	70.00	39	0.00	0.00	73	10.00	5.00
6	0.00	10.00	40	60.00	75.00	74	0.00	0.00
7	10.00	0.00	41	10.00	10.00	75	0.00	0.00
8	0.00	0.00	42	5.00	5.00	76	5.00	65.00
9	15.00	0.00	43	0.00	0.00	77	10.00	0.00
10	0.00	0.00	44	0.00	5.00	78	5.00	0.00
11	50.00	10.00	45	15.00	10.00	79	75.00	50.00
12	0.00	0.00	46	30.00	0.00	80	70.00	0.00
13	0.00	0.00	47	5.00	5.00	81	0.00	0.00
14	10.00	0.00	48	55.00	65.00	82	0.00	0.00
15	10.00	0.00	49	15.00	0.00	83	5.00	0.00
16	0.00	0.00	50	5.00	0.00	84	90.00	65.00
17	20.00	0.00	51	20.00	15.00	85	10.00	0.00
18	0.00	0.00	52	0.00	10.00	86	0.00	0.00
19	0.00	0.00	53	20.00	20.00	87	5.00	0.00
20	20.00	5.00	54	15.00	0.00	88	5.00	0.00
21	0.00	0.00	55	5.00	0.00	89	95.00	65.00
22	10.00	0.00	56	15.00	0.00	90	35.00	50.00
23	40.00	0.00	57	0.00	10.00	91	65.00	0.00
24	5.00	0.00	58	0.00	0.00	92	10.00	0.00
25	25.00	15.00	59	0.00	0.00	93	0.00	15.00
26	0.00	10.00	60	0.00	0.00	94	5.00	0.00
27	5.00	20.00	61	0.00	0.00	95	25.00	45.00
28	5.00	0.00	62	10.00	0.00	96	25.00	10.00
29	5.00	0.00	63	0.00	0.00	97	0.00	0.00
30	50.00	70.00	64	25.00	0.00	98	30.00	0.00
31	5.00	10.00	65	5.00	0.00	99	0.00	0.00
32	0.00	0.00	66	0.00	0.00	100	5.00	0.00

Contd...

Lines	Intensity of dormancy		Lines	Intensity of dormancy		Lines	Intensity of dormancy	
	Summer	Kharif		Summer	Kharif		Summer	Kharif
101	0.00	15.00	136	5.00	5.00	171	10.00	5.00
102	15.00	5.00	137	0.00	0.00	172	60.00	60.00
103	35.00	65.00	138	0.00	0.00	173	0.00	0.00
104	55.00	10.00	139	10.00	0.00	174	10.00	0.00
105	0.00	0.00	140	20.00	0.00	175	15.00	0.00
106	40.00	5.00	141	0.00	0.00	176	30.00	0.00
107	0.00	0.00	142	0.00	0.00	177	5.00	0.00
108	20.00	0.00	143	0.00	0.00	178	0.00	10.00
109	10.00	0.00	144	15.00	0.00	179	0.00	0.00
110	80.00	55.00	145	10.00	0.00	180	0.00	0.00
111	50.00	0.00	146	0.00	0.00	181	10.00	10.00
112	5.00	0.00	147	10.00	0.00	182	0.00	0.00
113	0.00	0.00	148	0.00	0.00	183	65.00	55.00
114	35.00	10.00	149	10.00	0.00	184	0.00	10.00
115	0.00	0.00	150	10.00	0.00	185	10.00	0.00
116	5.00	5.00	151	5.00	0.00	186	0.00	0.00
117	0.00	0.00	152	0.00	0.00	187	10.00	10.00
118	5.00	0.00	153	0.00	0.00	188	20.00	35.00
119	5.00	0.00	154	20.00	5.00	189	10.00	0.00
120	0.00	0.00	155	15.00	0.00	190	0.00	10.00
121	10.00	0.00	156	15.00	10.00	191	15.00	0.00
122	0.00	0.00	157	0.00	0.00	192	0.00	0.00
123	0.00	0.00	158	30.00	0.00	193	10.00	0.00
124	5.00	5.00	159	5.00	0.00	194	10.00	5.00
125	0.00	0.00	160	75.00	75.00	195	85.00	55.00
126	5.00	0.00	161	20.00	35.00	196	40.00	5.00
127	40.00	10.00	162	5.00	0.00	197	0.00	0.00
128	15.00	5.00	163	0.00	0.00	198	25.00	0.00
129	0.00	5.00	164	0.00	0.00	199	10.00	5.00
130	45.00	20.00	165	100.00	80.00	200	5.00	0.00
131	5.00	0.00	166	15.00	0.00	201	5.00	0.00
132	0.00	0.00	167	20.00	5.00	202	75.00	65.00
133	10.00	0.00	168	5.00	10.00	203	10.00	0.00
134	15.00	0.00	169	0.00	10.00	204	10.00	0.00
135	45.00	65.00	170	25.00	5.00	205	0.00	0.00

Contd...

Lines	Intensity of dormancy		Lines	Intensity of dormancy	
	Summer	Kharif		Summer	Kharif
206	0.00	0.00	237	20.00	55.00
207	5.00	0.00	238	0.00	0.00
208	0.00	0.00	239	0.00	0.00
209	90.00	90.00	240	0.00	0.00
210	0.00	0.00	241	0.00	5.00
211	5.00	10.00	242	40.00	50.00
212	0.00	15.00	243	10.00	5.00
213	70.00	90.00	244	5.00	0.00
214	40.00	0.00	245	40.00	30.00
215	0.00	0.00	246	5.00	0.00
216	30.00	35.00	247	65.00	70.00
217	75.00	65.00	248	70.00	70.00
218	5.00	0.00	249	0.00	0.00
219	5.00	55.00	250	15.00	0.00
220	50.00	65.00	251	10.00	0.00
221	0.00	0.00	252	15.00	0.00
222	55.00	0.00	253	0.00	5.00
223	0.00	0.00	254	70.00	75.00
224	0.00	5.00	255	60.00	20.00
225	5.00	0.00	256	5.00	10.00
226	10.00	15.00	257	35.00	90.00
227	0.00	0.00	258	0.00	5.00
228	0.00	0.00	259	70.00	80.00
229	0.00	0.00	260	10.00	30.00
230	30.00	15.00	261	0.00	0.00
231	0.00	0.00	262	0.00	0.00
232	5.00	45.00	263	10.00	20.00
233	0.00	5.00	264	0.00	10.00
234	5.00	0.00	265	80.00	65.00
235	15.00	0.00	266	40.00	50.00
236	5.00	35.00	267	50.00	90.00
			268	10.00	20.00

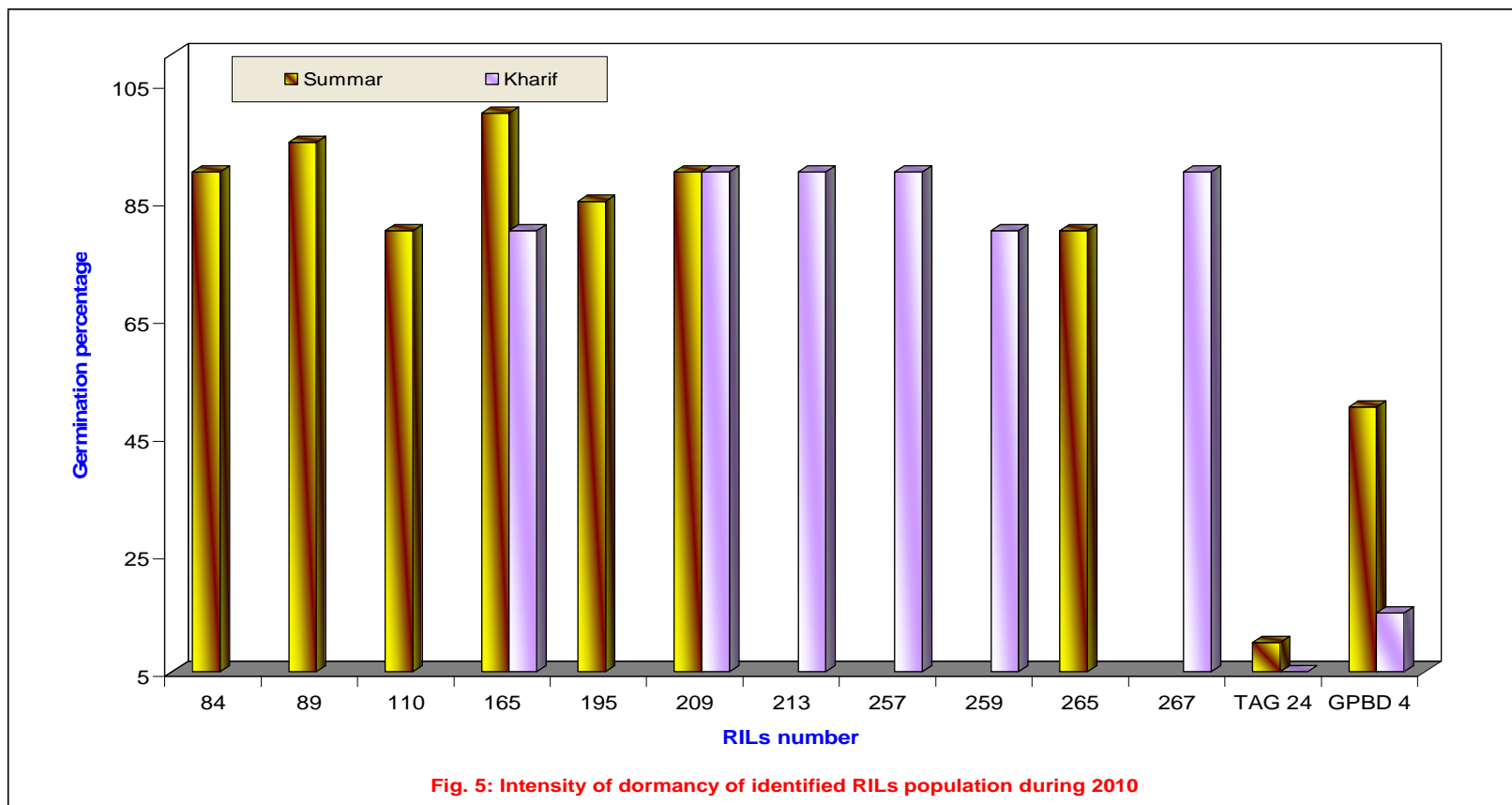


Fig. 5: Intensity of dormancy of identified RILs population during 2010

The parents TAG 24 recorded 4.52 values as G 70 during summer and *Kharif* seasons and GPBD 4 recorded 10.29 and 5.66 days as G 70 values during summer and *Kharif* respectively. Among 268 RILs population, 30 (5, 11, 23, 30, 40, 79, 80, 84, 89, 91, 104, 110, 111, 160, 165, 172, 183, 195, 202, 209, 213, 220, 222, 247, 248, 254, 255, 259, 265 and 267) lines recorded more than 10 days (Fig. 6) as G 70 values and among them 5 (40, 84, 209, 213 and 259) lines recorded high G 70 values (more than 25 days) during summer and in *Kharif* 33 lines (5, 30, 40, 72, 76, 79, 84, 90, 95, 103, 110, 135, 160, 165, 183, 195, 202, 209, 213, 216, 217, 219, 220, 232, 242, 247, 248, 254, 257, 259, 265, 266 and 267) exhibited more than 10 days (Fig. 7) as G 70 values and out of which 4 lines (5, 30, 213 and 267) showed high G 70 values as more than 25 days.

The RILs no. 5, 30 and 267 shows more than 36 days as G 70 value during *Kharif* season but during summer recorded less than 20 days as G 70 values. Whereas, RILs no. 40 and 84 recorded higher G 70 values (38.21 and 34.43 days) in summer but showed lesser G 70 (less than 25 days) values.

The RIL no. 209 exhibited 31.81 days in summer as G 70 value and the same recorded 23.39 days in *Kharif* season. While, the RIL no. 213 shown 28.57 days in summer and 27.75 days in *Kharif* and the RIL no. 259 recorded 33.57 and 18.061 days as G 70 value during summer and *Kharif* respectively.

4.2.4 Nature of dormancy

The detailed experimental results of the study made on nature of dormancy in dormant lines identified at 21 days after harvest is furnished in Table 16 and 17.

In case of with seed coat and without seed coat, analysis of variance indicated significant differences between RILs for germination percentage. High germination percentage (> 90%) are obtained for most of the lines studied.

The information regarding the germination percentage of dormancy in RILs of kernels with and without seed coat at two different seasons has been presented in Table 13. In *kharif*, the GPBD-4 a dormant genotype recorded 70 per cent germination whenever seed coats were not removed and recorded 80 per cent germination with seed coat. On the other hand, the highly dormant lines (RIL no 267, 209, 213, 254 and 259) recorded less than 50 per cent germination with seed coat and less than 80 per cent germination when seed coat is removed. Other dormant lines 84, 183 and 254 exhibited 90 per cent germination when seed coat is removed.

During summer, dormant lines RIL no 40, 84, 209 and 213 recorded less than 50 per cent germination percentage when with seed coat and less than 70 per cent germination when without seed coat while, other dormant line 183 and 259 recorded 90 and 80 per cent germination percentage when seed coat is removed (Table 14). Across seasons, the dormant lines 84, 209, 213 and 183 showed 90 per cent germination in without seed coat.

4.2.5 Inheritance pattern of dormancy in RILs of TAG 24 × GPBD 4

The chi-square test performed on RILs population derived from cross between TAG 24 × GPBD 4 fitted in the 15:1 (non-dormant : dormant) ratio at 14 days after harvest (< 70%) was non-significant ($P=3.841$) indicating that the trait is controlled by duplicate recessive gene (Table 14a).

4.3 Frequency of desirable segregants

The mean performance and magnitude of variation may not always indicate the potential segregants available for selection. Therefore, population was assessed for superior segregants for different characters and presented in Table 15 to 24 and Fig. 8 to 13. For dry pod yield, shelling percentage, SMK, kernel yield, dry pod yield per plant, rust and late leaf spot GPBD 4 was considered as check and for hundred kernel weight and days to 50 per cent flowering TAG 24 was considered as check and accordingly numerically superior segregants were counted. For the lines showing < 70 per cent germination were considered as dormant and lines having more than 13 days of duration were considered superior for that these character.

Table 12: Duration of dormancy (days) as shown by different dormant RILs at harvest during summer and *kharif* seasons

Lines	Duration of dormancy (G 70)		Lines	Duration of dormancy (G 70)		Lines	Duration of dormancy (G 70)	
	Summer	Kharif		Summer	Kharif		Summer	Kharif
TAG-24	4.52	4.52	33	4.52	3.44	67	6.30	4.52
GPBD-4	10.29	5.66	34	5.66	4.52	68	4.52	4.52
1	4.52	4.52	35	3.44	4.52	69	4.52	4.52
2	3.44	4.52	36	4.52	4.52	70	6.30	4.52
3	3.14	4.52	37	4.52	4.52	71	3.44	4.52
4	4.52	4.52	38	4.52	4.52	72	8.00	10.16
5	17.21	36.87	39	4.52	4.52	73	4.52	3.44
6	4.52	4.52	40	38.21	15.22	74	4.52	4.52
7	4.52	4.52	41	4.52	4.52	75	4.52	4.52
8	4.52	4.52	42	3.44	3.44	76	3.44	10.13
9	2.84	4.52	43	4.52	4.52	77	4.52	4.52
10	4.52	4.52	44	4.52	3.44	78	3.44	4.52
11	11.26	4.52	45	5.66	4.52	79	14.73	14.96
12	4.52	4.52	46	7.73	4.52	80	12.09	4.52
13	4.52	4.52	47	3.44	3.44	81	4.52	4.52
14	4.52	4.52	48	9.56	8.48	82	4.52	4.52
15	4.52	4.52	49	5.66	4.52	83	3.44	4.52
16	4.52	4.52	50	3.44	4.52	84	34.43	22.35
17	6.30	4.52	51	6.30	5.66	85	4.52	4.52
18	4.52	4.52	52	4.52	4.52	86	4.52	4.52
19	4.52	4.52	53	6.30	6.30	87	3.44	4.52
20	6.30	3.44	54	5.66	4.52	88	3.44	4.52
21	4.52	4.52	55	3.44	4.52	89	15.37	8.48
22	4.52	4.52	56	5.66	4.52	90	9.07	11.74
23	11.02	4.52	57	4.52	4.52	91	14.93	4.52
24	3.44	4.52	58	4.52	4.52	92	4.52	4.52
25	6.25	5.66	59	4.52	4.52	93	4.52	5.66
26	4.52	4.52	60	4.52	4.52	94	3.44	4.52
27	3.44	6.30	61	4.52	4.52	95	6.71	13.90
28	3.44	4.52	62	4.52	4.52	96	6.71	4.52
29	3.44	4.52	63	4.52	4.52	97	4.52	4.52
30	11.26	36.87	64	6.71	4.52	98	7.33	4.52
31	3.44	4.52	65	3.44	4.52	99	4.52	4.52
32	4.52	4.52	66	4.52	4.52	100	3.44	4.52

Contd...

Lines	Duration of dormancy (G 70)		Lines	Duration of dormancy (G 70)		Lines	Duration of dormancy (G 70)	
	Summer	Kharif		Summer	Kharif		Summer	Kharif
101	4.52	5.66	136	3.44	3.44	171	4.52	3.44
102	5.66	3.44	137	4.52	4.52	172	19.54	8.26
103	8.58	16.22	138	4.52	4.52	173	4.52	4.52
104	12.13	4.52	139	4.52	4.52	174	4.52	4.52
105	4.52	4.52	140	6.30	4.52	175	5.66	4.52
106	7.50	3.44	141	4.52	4.52	176	7.00	4.52
107	4.52	4.52	142	4.52	4.52	177	3.44	4.52
108	6.30	4.52	143	4.52	4.52	178	4.52	4.52
109	4.52	4.52	144	5.66	4.52	179	4.52	4.52
110	13.00	16.28	145	4.52	4.52	180	4.52	4.52
111	11.26	4.52	146	4.52	4.52	181	4.52	4.52
112	3.44	4.52	147	4.52	4.52	182	4.52	4.52
113	4.52	4.52	148	4.52	4.52	183	22.00	18.55
114	7.25	4.52	149	4.52	4.52	184	4.52	4.52
115	4.52	4.52	150	4.52	4.52	185	4.52	4.52
116	3.44	3.44	151	3.44	4.52	186	4.52	4.52
117	4.52	4.52	152	4.52	4.52	187	4.52	7.25
118	3.44	4.52	153	4.52	4.52	188	6.30	4.52
119	3.44	4.52	154	6.30	3.44	189	4.52	4.52
120	4.52	4.52	155	5.66	4.52	190	4.52	4.52
121	4.52	4.52	156	5.66	4.52	191	5.66	4.52
122	4.52	4.52	157	4.52	4.52	192	4.52	4.52
123	4.52	4.52	158	7.00	4.52	193	4.52	3.44
124	3.44	3.44	159	3.44	4.52	194	4.52	3.44
125	4.52	4.52	160	13.24	12.80	195	11.71	10.16
126	3.44	4.52	161	6.30	7.25	196	7.50	3.44
127	7.50	4.52	162	3.44	4.52	197	4.52	4.52
128	5.66	3.44	163	4.52	4.52	198	6.71	4.52
129	4.52	3.44	164	4.52	4.52	199	4.52	3.44
130	7.75	6.30	165	18.12	17.98	200	3.44	4.52
131	3.44	4.52	166	5.66	4.52	201	3.44	4.52
132	4.52	4.52	167	6.30	3.44	202	12.33	10.13
133	4.52	4.52	168	3.44	4.52	203	4.52	4.52
134	5.66	4.52	169	4.52	4.52	204	4.52	4.52
135	9.34	10.13	170	6.71	3.44	205	4.52	4.52

Contd...

Lines	Duration of dormancy (G 70)		Lines	Duration of dormancy (G 70)	
	Summer	Kharif		Summer	Kharif
206	4.52	4.52	237	6.30	8.27
207	3.44	4.52	238	4.52	4.52
208	4.52	4.52	239	4.52	4.52
209	31.81	23.39	240	4.52	4.52
210	4.52	4.52	241	4.52	3.44
211	4.52	4.52	242	7.50	10.78
212	4.52	5.66	243	4.52	3.44
213	28.57	27.75	244	3.44	4.52
214	7.50	4.52	245	7.50	7.00
215	4.52	4.52	246	3.44	4.52
216	7.00	10.10	247	13.19	11.03
217	8.96	10.13	248	12.57	18.15
218	3.44	4.52	249	4.52	4.52
219	3.44	16.70	250	5.66	4.52
220	10.29	15.48	251	4.52	4.52
221	4.52	4.52	252	5.66	4.52
222	10.29	4.52	253	4.52	3.44
223	4.52	4.52	254	12.09	17.88
224	4.52	3.44	255	11.53	6.30
225	3.44	4.52	256	3.44	4.52
226	4.52	5.66	257	8.15	19.74
227	4.52	4.52	258	4.52	3.44
228	4.52	4.52	259	33.57	18.07
229	4.52	4.52	260	4.52	7.00
230	7.00	5.66	261	4.52	4.52
231	4.52	4.52	262	4.52	4.52
232	3.44	10.31	263	4.52	6.30
233	4.52	3.44	264	4.52	4.52
234	3.44	4.52	265	13.44	11.83
235	5.66	4.52	266	8.81	11.74
236	3.44	7.25	267	17.21	37.85
			268	4.52	6.30

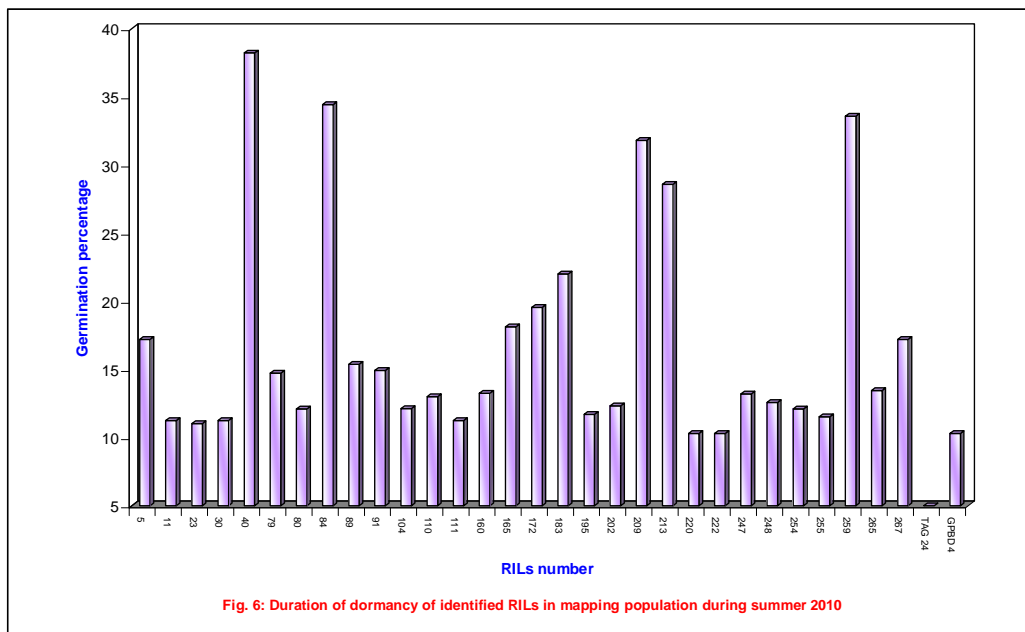


Fig. 6: Duration of dormancy of identified RILs in mapping population during summer 2010

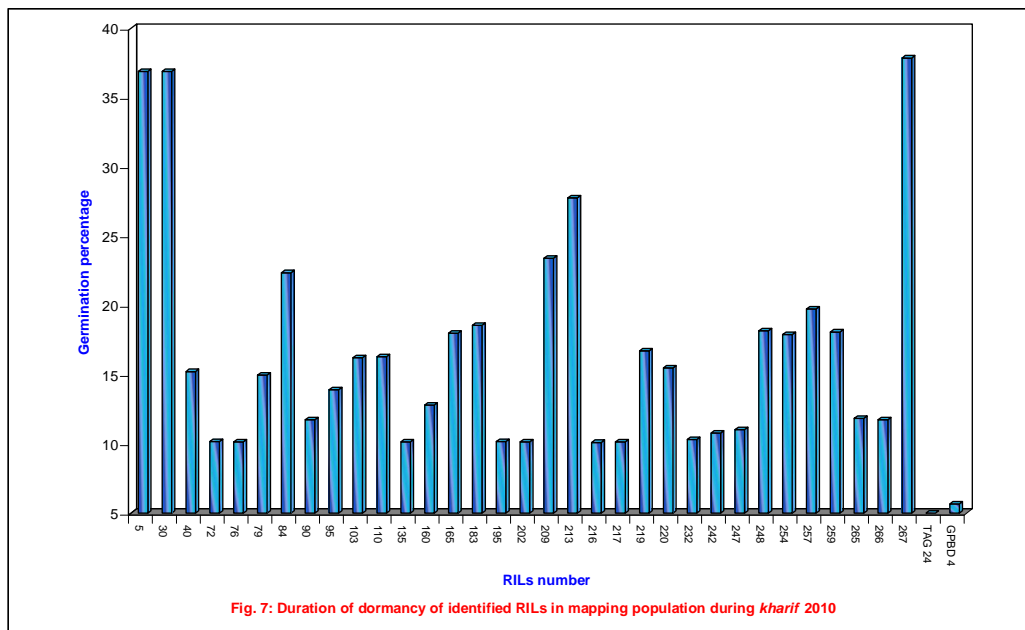


Fig. 7: Duration of dormancy of identified RILs in mapping population during kharif 2010

Table 13: Nature of dormancy in dormant lines at 21 days after harvest during *Kharif*

Genotypes	With seed coat	Without seed coat
TAG 24	100 (90.05)	100 (90.05)
GPBD 4	80 (63.47)	70(56.82)
5	50 (45.02)	70 (56.82)
259	70 (56.82)	100 (90.05)
209	40 (39.25)	80 (63.47)
213	50 (45.02)	90 (71.60)
254	70 (90.05)	100 (90.05)
267	30 (33.25)	70 (90.05)
84	60 (50.79)	90 (71.60)
183	60 (50.79)	90 (71.60)
254	70 (90.05)	100 (90.05)
SEm±	0.61	1.05
CD at 5%	2.73	4.70

*value in parenthesis indicates transformed value

Table 14: Nature of dormancy in dormant lines at 21 days after harvest during summer

Genotypes	With seed coat	Without seed coat
TAG 24	100 (90.05)	100 (90.05)
GPBD 4	90 (71.60)	80 (63.47)
40	50 (45.02)	70 (56.82)
84	40 (39.25)	70 (56.82)
183	60 (50.79)	90 (71.60)
209	40 (39.25)	60 (50.79)
213	50 (45.02)	70 (56.82)
259	60 (50.79)	80 (63.47)
SEm±	0.71	0.78
CD at 5%	3.54	3.86

* Value in parenthesis indicates transformed value

In the population during *kharif*, high frequency of segregants were recovered for shelling per cent (48.88%) followed by hundred kernel weight (25.37%) and for dormancy it was 12.68 and that for duration of dormancy it was 7.09. Comparatively less (4.10%) segregants were obtained for dry pod yield in the population (Table 15). When dry pod yield and dormancy considered together, the frequency of segregants was very less (0.74%) and the trend was similar as that for considering dry pod yield, dormancy and shelling per cent together (0.37%).

During summer, high frequency of segregants was recovered for dry pod yield per plant (85.82%) followed by kernel yield (66.79%) and SMK (39.55%). For dormancy it was 10.82 per cent and that for duration of dormancy it was 5.60 per cent. Comparatively less (4.10%) segregants were obtained for dry pod yield per plant followed by hundred kernel weight (4.80%) and shelling per cent (5.60%) in the population. When dry pod yield and dormancy considered together, the frequency of segregants was very less (0.37%) and there is no segregants obtained when considering dry pod yield, dormancy and shelling per cent together (Table 15).

Taking dormancy (14 DAS) in consideration totally 16 lines during summer (Table 16 and Fig. 8) and 22 lines during *kharif* (Table 18 and Fig. 9) were selected. These lines were selected for dormancy based on the lines showing less 70 per cent germination were considered as dormant indicating the usefulness of dormant genotypes in yielding segregants combining dry pod yield per plant. When these lines were assessed for combination of characters, there were some lines which were having one or more desirable characters along with dormancy (Table 17 and 19).

Out of 16 dormant lines selected during summer, as many as 13 lines were found superior for dry pod yield per plant, seven lines for SMK, seven lines for kernel yield per plant and none of the lines were found superior for hundred kernel weight, dry pod yield (kg/ha) and shelling per cent. The RIL no. 183 showed less than 40 per cent germination recorded higher yield (g/plant) than GPBD 4 and recorded moderate intensity (65.00%) and duration of dormancy (22 days) (Table 17) and the RIL no. 247 and 104 recorded higher yield and high SMK, kernel yield but moderately dormant having 70 per cent germination. The RIL no 84, 209 and 40 recorded less than 50 per cent germination and high intensity and duration (> 30 days) of dormancy but recorded moderately high yield (g/plant) than GPBD 4 (Table 17 and Fig. 8).

Among 22 lines selected during *kharif*, as many as 8 lines (RIL no. 165, 30, 40, 213, 219, 220, 110 and 90) showed superior for hundred kernel weight, 5 lines (RIL no. 90, 110, 219, 248 and 84) for shelling per cent and two lines (RIL no 248 and 110) showed superior for dry pod yield and kernel yield per plant. However the RIL no.248 and 110 (Table 19 and Fig. 9) which has dormant having 50 per cent germination exhibited higher dry pod yield per plant (> 27.0 g) and dry pod yield of more than 2700 kg/ha which is having lesser than GPBD 4 but recorded moderate intensity (70%) and duration (15 – 18 days) of dormancy. The highly dormant line (RIL no. 267 with 15% germination) recorded 100 per cent SMK with higher dry pod yield per plant (20.40 g) and high intensity (90%) and duration (37.84 days) of dormancy (Table 19). The RIL no 5 and 30 also recorded high intensity and duration (36 days) of dormancy but less dry pod weight.

At 21 days after harvest seven and six dormant superior lines were selected during *kharif* (Table 22 and Fig. 11) and summer (Table 21 and Fig. 10) respectively and RIL no 84, 213, 209 and 183 were found superior lines in both seasons. At 28 days after harvest four and five superior dormant lines were identified during *kharif* (Table 24 and Fig. 13) and summer (Table 23 and Fig. 12) respectively and of which, RIL no 213 was found superior line in both seasons with more than 70 per cent intensity and more than 25 days of dormancy with moderate dry pod weight per plant.

4.4 Frequency distribution, mean and range

The frequency distribution among the RILs in comparison with parents is given in the figures (Fig. 14 to 26). X-axis represents traits which are divided into equal class intervals and Y-axis represents the genotype frequencies and range of traits.

Table 14a: Inheritance pattern of dormancy in RILs of TAG24 x GPBD4 at 14 days

RILs	Summer 2009-10	Kharif 2010	X ² value	
			Calculated	Table
Dormant	Observed 12.00	18.00	1.435	3.841
	Expected 16.75	16.75		
Non-Dormant	Observed 256.00	250.00	0.009	
	Expected 251.25	251.25		
Total	Observed 268.00	268.00		

Duplicate recessive gene for dormancy

Table 15: Frequency of desirable segregants for various parameters in the population

Characters	Kharif	Summer
DFF	268 (100.0)	74 (27.61)
SMK	129 (48.13)	106 (39.55)
LLS@70	0 (0)	40 (14.92)
Rust@70	0 (0)	63 (23.50)
LLS@80	0 (0)	0 (0)
Rust@80	0 (0)	0 (0)
LLS@90	0 (0)	0 (0)
Rust@90	0 (0)	0 (0)
Kernal Yield (KY)	6 (2.24)	179 (66.79)
Shelling percent (SP)	131 (48.88)	15 (5.60)
Hundred kernal weight (HKW)	68 (25.37)	13 (4.80)
Dry pod yield per plant	28 (10.44)	230 (85.82)
Dormancy	34 (12.68)	29 (10.82)
Duration of dormancy (DFG)	19 (7.09)	15 (5.60)
Dry pod yield (DPY)	11 (4.10)	11 (4.10)
Dry pod yield + Dormancy	2 (0.74)	1 (0.37)
Dry pod yield + Dormancy + Shelling percent	1 (0.37)	0 (0)

Parenthesis value indicates percentage

Table 16: List of superior lines selected for further evaluation based on dormancy during summer (14 DAH)

RILs No.	Germination (%)	DFF	Rust @ 90	LLS @ 90	SP (%)	HKW (g)	SMK (%)	KY (g/plant)	DPY (g/plant)	Intensity of dormancy	Duration of dormancy
84	25.00	37.00	4.00	3.00	70.50	43.50	93.65	9.51	13.49	75	34.432
209	30.00	36.50	4.00	3.00	58.00	36.00	87.13	7.58	13.04	70	31.812
183	40.00	38.50	4.50	4.00	48.75	33.50	85.41	10.95	22.50	60	22.00
213	40.00	37.00	4.00	4.00	59.25	37.00	87.20	8.26	14.01	60	28.565
40	45.00	36.00	4.50	5.00	59.75	36.50	92.72	8.69	14.51	55	38.206
259	45.00	39.50	4.00	3.00	62.25	38.50	82.24	8.66	13.95	55	33.572
89	50.00	37.00	3.50	3.50	67.25	39.50	88.25	10.39	15.35	50	15.373
165	50.00	37.00	5.50	3.50	70.00	38.50	97.57	8.40	12.00	50	18.121
91	60.00	36.50	4.50	4.00	60.25	40.00	79.58	8.87	14.71	40	14.933
247	65.00	39.50	4.50	4.00	69.00	36.00	94.74	13.34	19.33	35	13.193
79	70.00	38.50	4.00	4.00	67.75	34.00	79.87	8.68	12.78	30	14.731
104	70.00	37.00	3.50	3.50	70.50	43.00	92.13	13.77	19.56	30	12.125
160	70.00	37.50	4.50	5.00	72.00	41.50	89.47	10.43	14.48	30	13.4
265	70.00	36.50	4.50	4.50	71.75	37.50	94.75	8.32	11.53	30	13.441
5	65	36.50	3.50	4.50	65.50	42.50	80.57	8.71	14.01	35	17.219
267	60	37.50	4.50	3.00	50.50	36.50	76.74	9.71	19.23	40	17.219
TAG24	100	39.00	6.00	7.50	72.00	48.00	90.96	6.99	9.71	0	4.52
GPBD4	85	38.00	2.00	2.00	75.00	42.50	85.34	9.02	12.05	15	10.29
CD at5%	7.822	5.378	2.721	2.313	13.359	10.134	25.029	3.997	4.691	7.823	0.618
SEm±	1.861	1.274	0.644	0.548	3.166	2.401	5.931	0.947	1.111	1.861	0.147

Note : df – Degrees of freedom kernel

DFF – Days to Fifty per cent flowering

SP (%) – Shelling per cent

SMK (%) – Sound mature

HKW (g) – Hundred kernel weight (g)

KY (g/plant) – Kernel yield (g/plant)

DPY (g/plant) – Dry pod yield (g/plant)

LLS – Late leaf spot

Table 17: Superior RILs identified for intensity, duration of dormancy, yield and yield components during summer (14 DAH)

RILs No.	Dormancy	Intensity of dormancy	Duration of dormancy	RILs No.	DFF	RILs No.	SMK (%)	RILs No.	KY (g/plant)	RILs No.	DPY (g/plant)
84*	25	90	34.432	40*	36	165*	97.57	104*	13.77	183	22.5
209*	30	90	31.812	209*	36.5	265*	94.75	247*	13.34	104*	19.56
183*	40	65	22	91*	36.5	247*	94.74	183*	10.95	247*	19.33
213*	40	70	28.565	265	36.5	84*	93.65	160*	10.43	267*	19.23
40*	45	60	38.206	5*	36.5	40*	92.72	89*	10.39	89*	15.35
259*	45	70	33.572	84*	37	104*	92.13	267	9.71	91*	14.71
89*	50	95	15.373	213*	37			84*	9.51	40*	14.51
165*	50	100	18.121	89*	37					160*	14.48
91*	60	65	14.933	165*	37					213*	14.01
247*	65	65	13.193	104*	37					5*	14.01
79*	70	75	14.731	160*	37.5					259*	13.95
104*	70	55	12.125	267*	37.5					84	13.49
160*	70	75	13.4							209*	13.04
265*	70	80	13.441							79*	12.78
5*	65	50	17.219								
267*	60	50	17.219								
TAG24	100	10	4.52	TAG24	39.00	TAG24	90.96	TAG24	6.99	TAG24	9.71
GPBD4	85	50	10.29	GPBD4	38.00	GPBD4	85.34	GPBD4	9.02	GPBD4	12.05

* indicates superior for more than one character

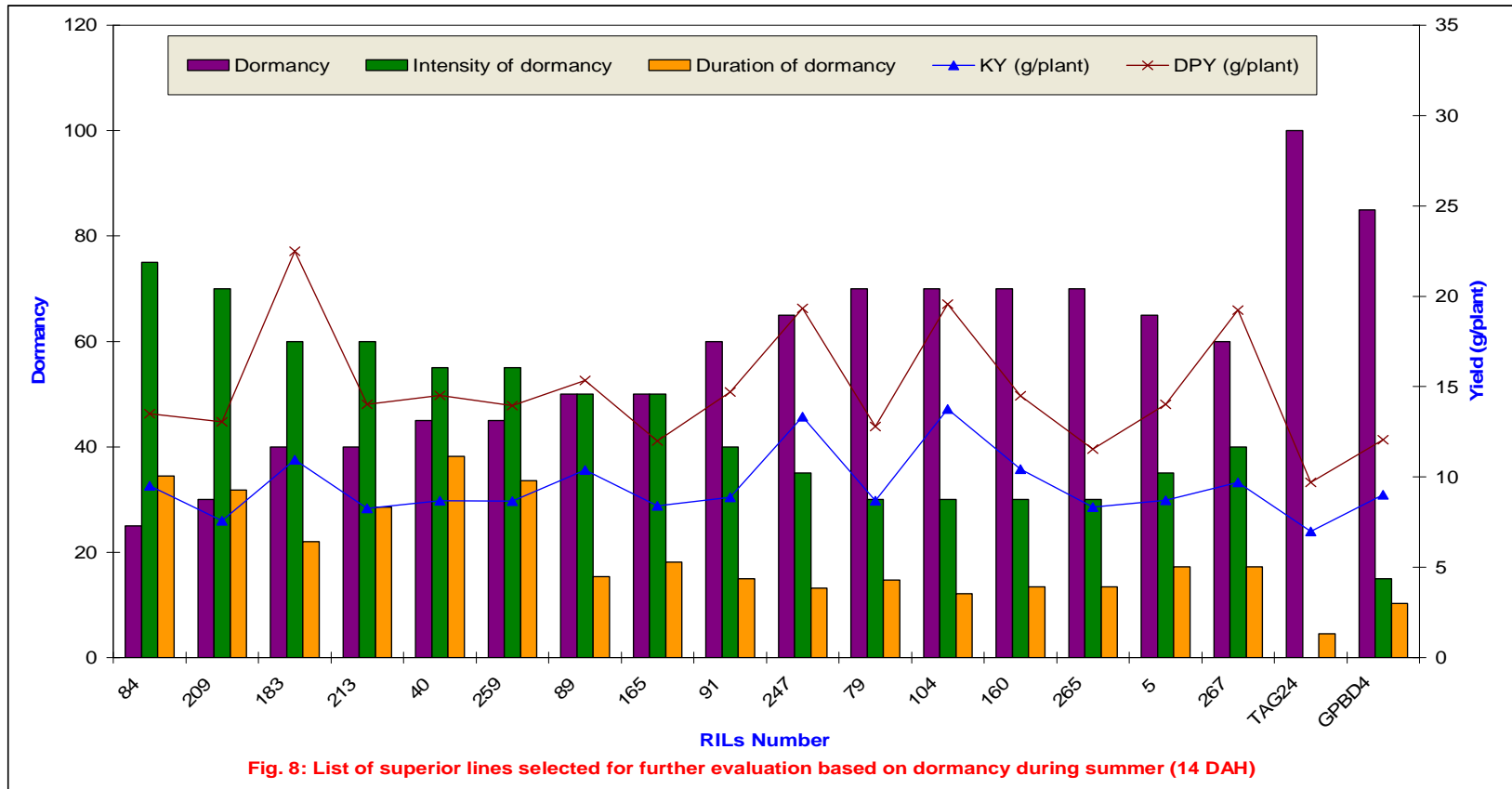


Fig. 8: List of superior lines selected for further evaluation based on dormancy during summer (14 DAH)

Table 18: List of superior lines selected for further evaluation based on dormancy during *kharif* (14 DAH)

RILs No.	Germination (%)	DFF	Rust @ 90	LLS @ 90	SP (%)	HKW (g)	SMK (%)	KY (g/plant)	DPY (g/plant)	Intensity of dormancy	Duration of dormancy	Oil	Protein
267	15	30.50	4.00	8.50	73.00	38.00	100.00	14.94	20.40	85	37.846	48.49	30.30
165	25	30.00	8.00	5.50	63.00	47.00	91.42	16.21	25.65	75	17.978	46.37	29.50
209	25	30.00	6.50	4.50	72.00	41.00	100.00	17.12	23.85	75	23.394	47.52	26.73
257	25	30.50	7.50	4.00	71.00	43.00	95.35	15.30	21.54	75	19.735	46.74	28.07
5	35	31.00	6.00	5.50	67.00	42.00	89.32	10.63	15.68	65	36.866	48.85	27.15
30	35	30.50	4.50	7.50	69.00	49.00	88.60	13.40	19.45	65	36.866	51.22	34.93
84	35	30.50	6.00	7.00	78.00	43.00	93.48	16.72	21.36	65	22.349	47.38	29.86
103	35	30.50	4.50	8.00	69.00	45.00	100.00	11.93	17.37	65	16.218	48.60	28.75
248	35	30.00	6.50	7.50	81.00	39.00	100.00	22.41	27.71	65	18.417	47.61	28.79
40	45	30.00	6.50	7.50	75.00	49.00	100.00	12.82	17.10	65	15.224	49.17	27.42
183	45	31.00	6.00	7.50	70.00	42.00	96.39	17.12	24.40	55	18.552	48.00	28.34
213	45	30.00	5.50	7.50	76.00	49.00	97.22	17.21	22.65	55	27.748	45.37	26.67
219	45	29.50	4.00	5.00	82.00	50.00	94.06	20.43	24.83	55	16.704	45.28	29.44
220	45	31.00	6.50	4.00	76.00	51.00	100.00	16.96	22.33	55	15.488	47.64	28.31
110	50	30.00	4.00	6.00	77.00	47.00	100.00	21.60	28.10	50	16.247	46.60	29.43
254	50	31.00	4.00	4.50	56.00	43.00	100.00	11.33	20.43	50	17.882	48.45	28.91
259	50	30.00	7.50	4.50	67.00	40.00	100.00	15.14	22.61	50	18.068	49.19	31.61
79	60	30.50	4.50	7.50	67.00	44.00	74.78	10.53	15.78	40	14.957	47.93	30.67
95	65	31.00	4.50	8.00	68.00	45.00	94.62	14.05	20.75	35	13.895	46.81	28.28
90	70	30.00	8.00	5.00	80.00	46.00	100.00	16.47	20.55	30	11.736	46.92	28.50
216	70	30.00	5.00	8.00	74.00	45.00	100.00	16.32	22.00	30	10.099	49.51	30.92
266	70	30.50	4.50	8.50	65.00	36.00	89.02	13.19	20.40	30	11.736	44.63	27.37
TAG24	100	30.00	7.00	9.00	73.50	46.00	97.25	14.29	19.45	0	4.52	45.38	25.60
GPBD4	85	30.00	3.00	3.00	77.00	42.00	91.88	21.14	27.46	15	5.66	48.25	31.40
CD at 5%	10.734	1.168	2.225	1.592	20.460	12.881	20.360	5.571	4.450	10.381	0.514	5.357	9.154
SE m±	2.600	0.282	0.545	0.384	4.945	3.113	4.21	1.346	1.075	2.059	0.124	0.957	1.636

Note : df – Degrees of freedom kernel

HKW(g) – Hundred kernel weight (g)

DFF – Days to Fifty per cent flowering

KY (g/plant) – Kernel yield (g/plant)

SP (%) – Shelling per cent

DPY (g/plant) – Dry pod yield (g/plant)

SMK (%) – Sound mature

LLS – Late leaf spot

Table 19: Superior RILs identified for intensity, duration of dormancy, yield, yield components and nutritional quality during kharif (14 DAH)

RILs No.	Dormancy	Intensity of dormancy	Duration of dormancy	RILs No.	DFP	RILs No.	SP (%)	RILs No.	HKW (g)	RILs No.	SMK (%)	RILs No.	KY (g/plant)	RILs No.	DPY (g/plant)	RILs No.	Oil	RILs No.	Protein
267*	15	90	37.846	219*	29.5	219*	82	220*	51	267*	100	248*	22.41	110*	28.1	30	51.22	30	34.93
165*	25	80	17.978	165*	30	248*	81	219*	50	209*	100	110*	21.6	248*	27.71	216*	49.51	259*	31.61
209*	25	90	23.394	209*	30	90	80	30	49	103*	100					259*	49.19		
257	25	90	19.735	248*	30	84*	78	40*	49	248*	100					40*	49.17		
5*	35	70	36.866	40*	30	110*	77	213*	49	40*	100					5*	48.85		
30	35	70	36.866	213*	30			165*	47	220*	100					103*	48.6		
84*	35	55	22.349	110*	30			110*	47	110*	100					267*	48.49		
103*	35	65	16.218	259*	30			90*	46	254*	100					254*	48.45		
248*	35	70	18.417	90*	30					259*	100								
40*	45	75	15.224	216*	30					90*	100								
183	45	55	18.552							216*	100								
213*	45	90	27.748							213*	97.22								
219*	45	55	16.704																
220*	45	65	15.488																
110*	50	55	16.247																
254*	50	75	17.882																
259*	50	80	18.068																
79	60	50	14.957																
95	65	45	13.895																
90*	70	50	11.736																
216*	70	35	10.099																
266	70	50	11.736																
TAG24	100	0	4.52	TAG24	30	TAG24	73.5	TAG24	46	TAG24	97.25	TAG24	14.29	TAG24	19.45	TAG24	45.38	TAG24	25.60
GPBD4	85	15	5.66	GPBD4	30	GPBD4	77	GPBD4	42	GPBD4	91.88	GPBD4	21.14	GPBD4	27.46	GPBD4	48.25	GPBD4	31.40

* indicates superior for more than one character

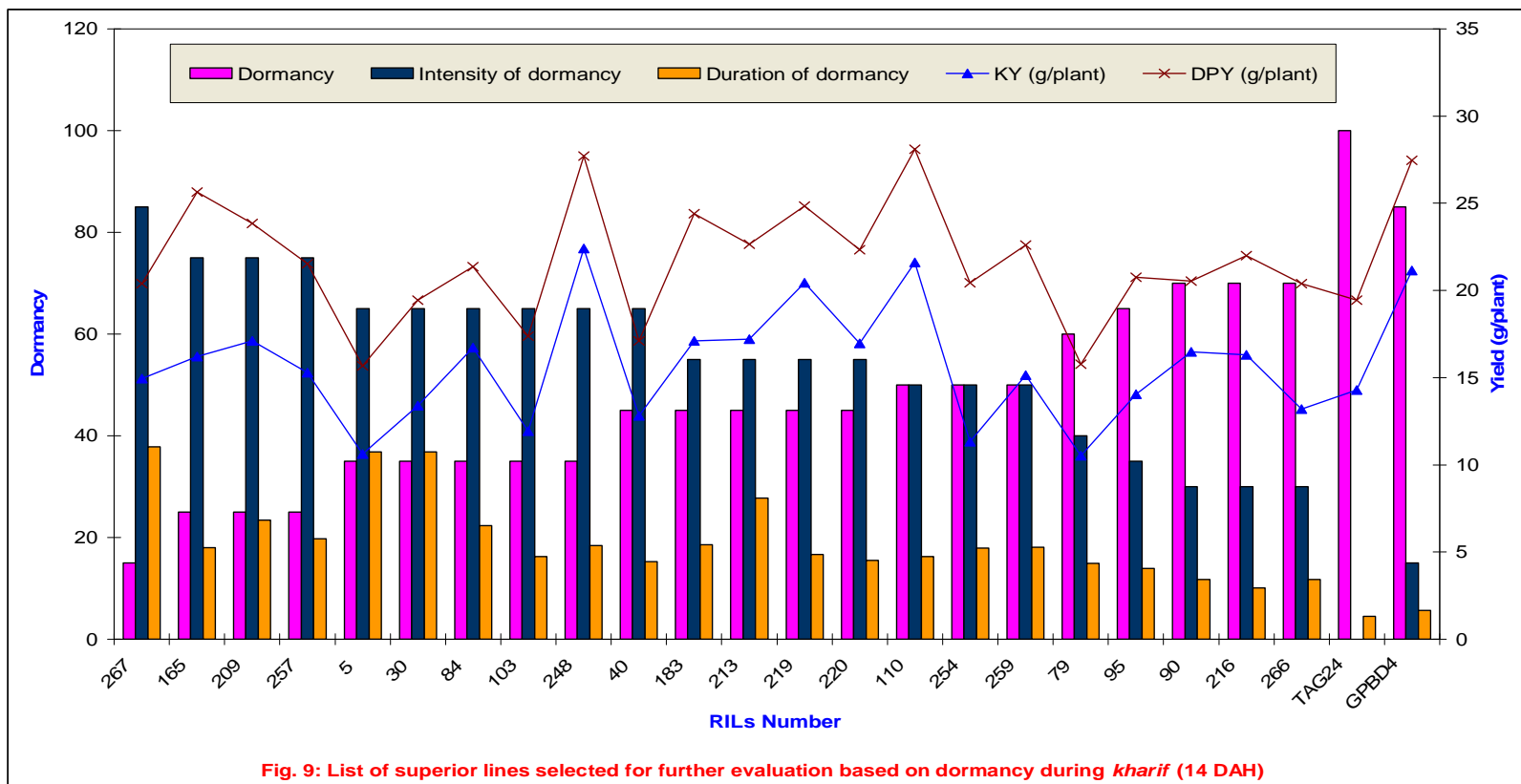


Fig. 9: List of superior lines selected for further evaluation based on dormancy during *kharif* (14 DAH)

Table 20: List of superior RILs identified in mapping population at both seasons (14 DAH)

RILs No.	Germination (%)	DFF	Rust @ 90	LLS @ 90	SP (%)	HKW (g)	SMK (%)	KY (g/plant)	DPY (g/plant)	Intensity of dormancy	Duration of dormancy
5	50.00	33.75	4.75	5.00	66.25	42.25	84.95	9.67	14.85	50.00	27.04
40	45.00	33.00	5.50	6.25	67.38	42.75	96.36	10.76	15.81	60.00	26.72
84	30.00	33.75	5.00	5.00	74.25	43.25	93.57	13.12	17.43	70.00	28.39
165	37.50	33.50	6.75	4.50	66.50	42.75	94.50	12.31	18.83	62.50	18.05
183	42.50	34.75	5.25	5.75	59.38	37.75	90.90	14.04	23.45	57.50	20.28
209	27.50	33.25	5.25	3.75	65.00	38.50	93.57	12.35	18.45	72.50	27.60
213	42.50	33.50	4.75	5.75	67.63	43.00	92.21	12.74	18.33	57.50	28.16
259	47.50	34.75	5.75	3.75	64.63	39.25	91.12	11.90	18.28	52.50	25.82
267	37.50	34.00	4.25	5.75	61.75	37.25	88.37	12.33	19.82	62.50	27.53
TAG24	100.00	34.50	6.50	8.25	72.75	47.00	94.11	10.64	14.58	0.00	4.52
GPBD4	85.00	34.00	2.50	2.50	76.00	42.25	88.61	15.08	19.76	15.00	7.98
SEm±	3.386	0.626	0.504	0.337	2.405	2.194	2.886	0.743	0.706	5.253	0.130
CD at 5%	14.909	2.790	2.248	1.502	10.720	9.779	12.863	3.314	3.149	23.125	0.574

Note : df – Degrees of freedom
mature kernel

HKW (g) – Hundred kernel weight (g)
spot

DFF – Days to Fifty per cent flowering

KY (g/plant) – Kernel yield (g/plant)

SP (%) – Shelling per cent

DPY (g/plant) – Dry pod yield (g/plant)

SMK (%) – Sound

LLS – Late leaf

Table 21: List of superior lines selected for further evaluation based on dormancy during summer (21 DAH)

RILs No.	Germination (%)	DFF	Rust @ 90	LLS @ 90	SP (%)	HKW (g)	SMK (%)	KY (g/plant)	DPY (g/plant)	Intensity of dormancy	Duration of dormancy
84	35*	37.00	4.00	3.00	70.50	43.50	93.65*	9.51*	13.49*	65*	34.43*
209	40*	36.50	4.00	3.00	58.00	36.00	87.13	7.58	13.04*	60*	31.81*
40	55*	36.00	4.50	5.00	59.75	36.50	92.72*	8.69	14.51*	45*	38.21*
213	55*	37.00	4.00	4.00	59.25	37.00	87.20	8.26	14.01*	45*	28.57*
259	55*	39.50*	4.00	3.00	62.25	38.50	82.24	8.66	13.95*	45*	33.57*
183	60*	38.50	4.50	4.00	48.75	33.50	85.41	10.95*	22.50*	40*	22.00*
TAG24	100	39.00	6.00	7.50	72.00	48.00	90.96	6.99	9.71	0	4.52
GPBD4	100	38.00	2.00	2.00	75.00	42.50	85.34	9.02	12.05	0	10.29
CD at 5%	9.515	6.444	3.096	2.662	16.969	14.156	21.386	3.177	4.326	2.063	0.782
SE m \pm	2.063	1.362	0.645	0.582	3.588	2.993	4.522	0.671	0.914	2.063	0.169

Note : df – Degrees of freedom
mature kernel

HKW (g) – Hundred kernel weight (g)
spot

* - Indicates superior over parents

DFF – Days to Fifty per cent flowering

KY (g/plant) – Kernel yield (g/plant)

SP (%) – Shelling per cent

DPY (g/plant) – Dry pod yield (g/plant)

SMK (%) – Sound

LLS – Late leaf

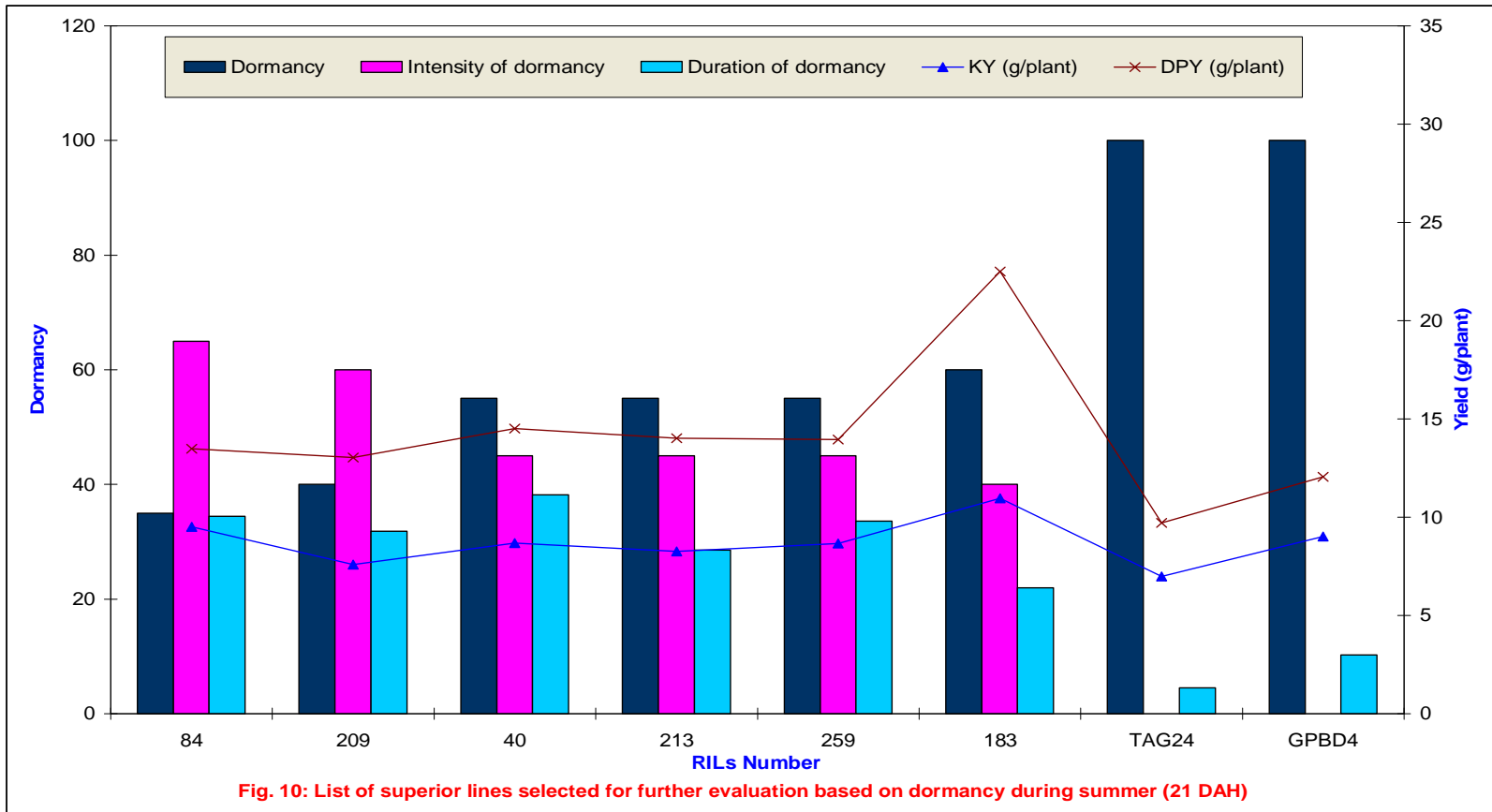


Fig. 10: List of superior lines selected for further evaluation based on dormancy during summer (21 DAH)

Table 22: List of superior lines selected for further evaluation based on dormancy during *kharif* (21 DAH)

RILs No.	Germination (%)	DFF	Rust @ 90	LLS @ 90	SP (%)	HKW (g)	SMK (%)	KY (g/plant)	DPY (g/plant)	Intensity of dormancy	Duration of dormancy	Oil	Protein
267	25*	30.50*	4.00	8.50	73.00	38.00	100.00*	14.94	20.40	75*	37.85*	48.49*	30.30
209	35*	30.00	6.50	4.50	72.00	41.00	100.00*	17.12	23.85	65*	23.39*	47.52	26.73
5	45*	31.00*	6.00	5.50	67.00	42.00	89.32	10.63	15.68	55*	36.87*	48.85*	27.15
30	45*	30.50*	4.50	7.50	69.00	49.00*	88.60	13.40	19.45	55*	36.87*	51.22*	34.93*
213	55*	30.00	5.50	7.50	76.00	49.00*	97.22*	17.21	22.65	45*	27.75*	45.37	26.67
84	60*	30.50	6.00	7.00	78.00*	43.00	93.48	16.72	21.36	40*	22.35*	47.38	29.86
183	65*	31.00*	6.00	7.50	70.00	42.00	96.39	17.12	24.40	35*	18.552*	48.00	28.34
TAG24	100	30.00	7.00	9.00	73.50	46.00	97.25	14.29	19.45	0	4.52	45.38	25.60
GPBD4	85	30.00	3.00	3.00	77.00	42.00	91.88	21.14	27.46	15	5.66	48.25	31.40
CD at 5%	12.682	1.153	2.850	1.921	16.91	9.224	25.945	4.693	4.239	10.580	0.721	3.993	6.083
SE m±	2.803	0.25	0.618	0.416	3.666	2.000	5.625	1.017	0.919	2.294	0.159	0.882	1.344

Note : df – Degrees of freedom
mature kernel

HKW (g) – Hundred kernel weight (g)
spot

* - Indicates superior over parents

DFF – Days to Fifty per cent flowering

KY (g/plant) – Kernel yield (g/plant)

SP (%) – Shelling per cent

DPY (g/plant) – Dry pod yield (g/plant)

SMK (%) – Sound

LLS – Late leaf

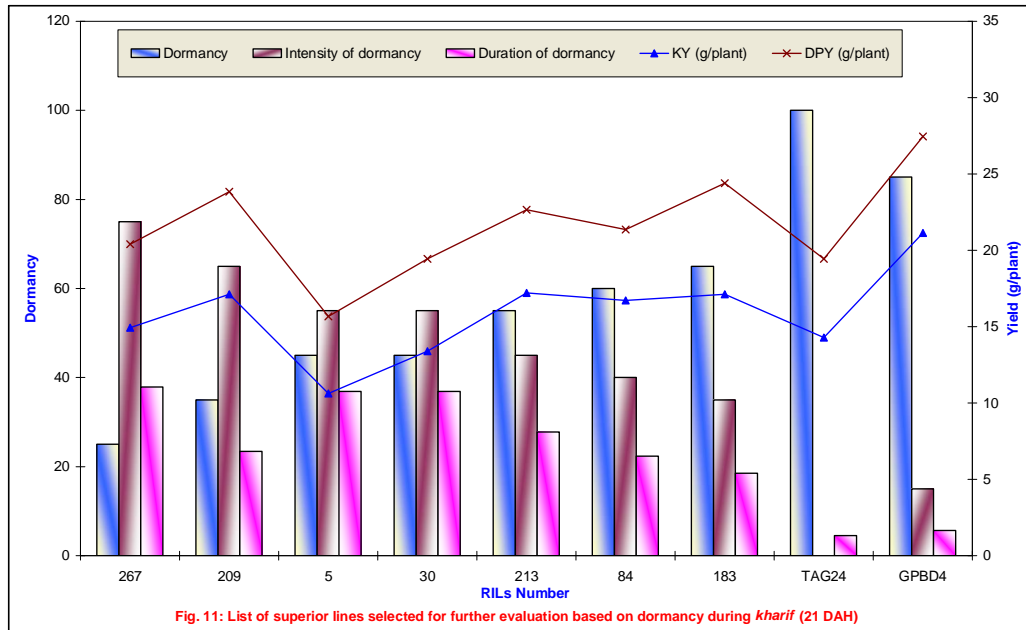


Fig. 11: List of superior lines selected for further evaluation based on dormancy during kharif (21 DAH)

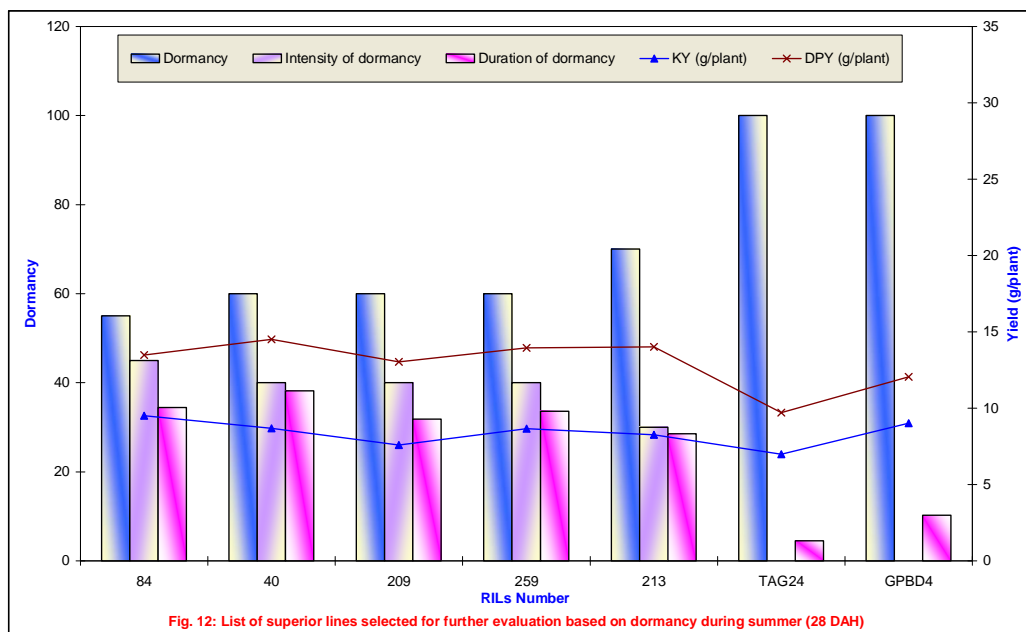


Fig. 12: List of superior lines selected for further evaluation based on dormancy during summer (28 DAH)

Table 23: List of superior lines selected for further evaluation based on dormancy during summer (28 DAH)

RILs No.	Germination (%)	DFF	Rust @ 90	LLS @ 90	SP (%)	HKW (g)	SMK (%)	KY (g/plant)	DPY (g/plant)	Intensity of dormancy	Duration of dormancy
84	55*	37.00	4.00	3.00	70.50	43.50	93.65*	9.51*	13.49*	45*	34.43*
40	60*	36.00	4.50	5.00	59.75	36.50	92.72*	8.69	14.51*	40*	38.21*
209	60*	36.50	4.00	3.00	58.00	36.00	87.13	7.58	13.04*	40*	31.81*
259	60*	39.50*	4.00	3.00	62.25	38.50	82.24	8.66	13.95*	40*	33.57*
213	70*	37.00	4.00	4.00	59.25	37.00	87.20	8.26	14.01*	30*	28.57*
TAG24	100	39.00	6.00	7.50	72.00	48.00	90.96	6.99	9.71	0	4.52
GPBD4	100	38.00	2.00	2.00	75.00	42.50	85.34	9.02	12.05	0	10.29
CD at 5%	5.158	6.879	2.201	1.925	18.919	13.231	23.489	3.337	3.987	5.158	0.857
SE m±	1.090	1.405	0.449	0.393	3.566	2.703	4.779	0.681	0.814	1.090	0.181

Note : df – Degrees of freedom

HKW (g) – Hundred kernel weight (g)

* - Indicates superior over parents

DFF – Days to Fifty per cent flowering

SP (%) – Shelling per cent

KY (g/plant) – Kernel yield (g/plant)

DPY (g/plant) – Dry pod yield (g/plant)

SMK (%) – Sound mature kernel

LLS – Late leaf spot

Table 24: List of superior lines selected for further evaluation based on dormancy during *Kharif* (28 DAH)

RILs No.	Germination (%)	DFF	Rust @ 90	LLS @ 90	SP (%)	HKW (g)	SMK (%)	KY (g/plant)	DPY (g/plant)	Intensity of dormancy	Duration of dormancy	Oil	protein
267	50*	30.50*	4.00	8.50	73.00	38.00	100.00*	14.94	20.40	50*	37.85*	48.49*	30.30
5	60*	31.00*	6.00	5.50	67.00	42.00	89.32	10.63	15.68	40*	36.87*	48.85*	27.15
30	60*	30.50	4.50	7.50	69.00	49.00*	88.60	13.40	19.45	40*	36.87*	51.22	34.93*
213	65*	30.00	5.50	7.50	76.00	49.00*	97.22	17.21	22.65	35*	27.75*	45.37	26.67
TAG24	100	30.00	7.00	9.00	73.50	46.00	97.25	14.29	19.45	0	4.52	45.38	25.60
GPBD4	100	30.00	3.00	3.00	77.00	42.00	91.88	21.14	27.46	0	5.66	48.25	31.40
CD at 5%	6.017	1.153	3.051	1.997	14.296	9.546	27.856	4.592	4.948	5.493	0.820	4.001	5.746
SE m±	1.22	0.235	0.623	0.408	2.921	1.950	5.692	0.938	1.001	1.122	0.167	0.817	1.174

Note : df – Degrees of freedom

HKW (g) – Hundred kernel weight (g)

* - Indicates superior over parents

DFF – Days to Fifty per cent flowering

KY (g/plant) – Kernel yield (g/plant)

SP (%) – Shelling per cent

DPY (g/plant) – Dry pod yield (g/plant)

SMK (%) – Sound mature kernel

LLS – Late leaf spot

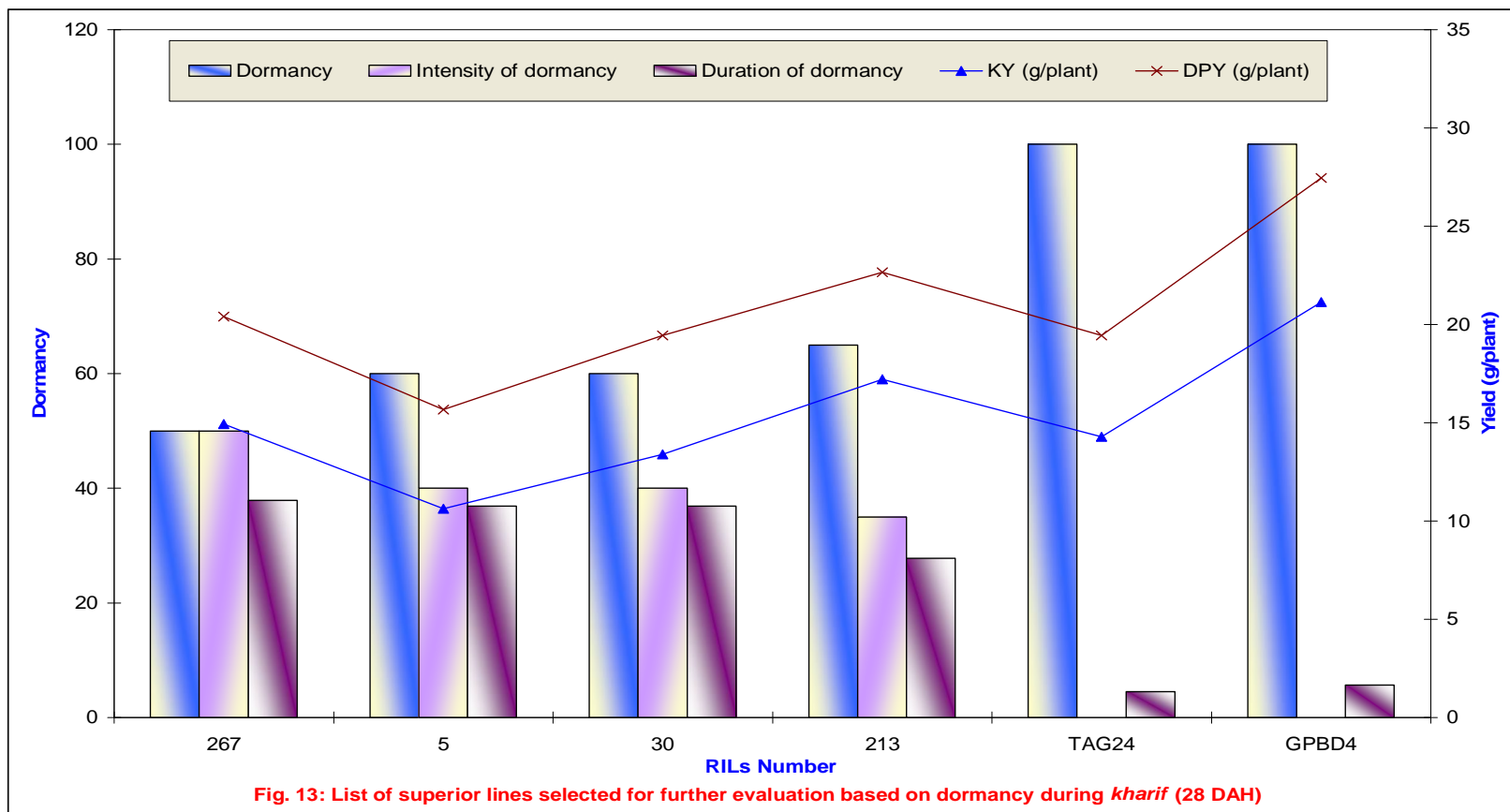


Fig. 13: List of superior lines selected for further evaluation based on dormancy during *kharif* (28 DAH)

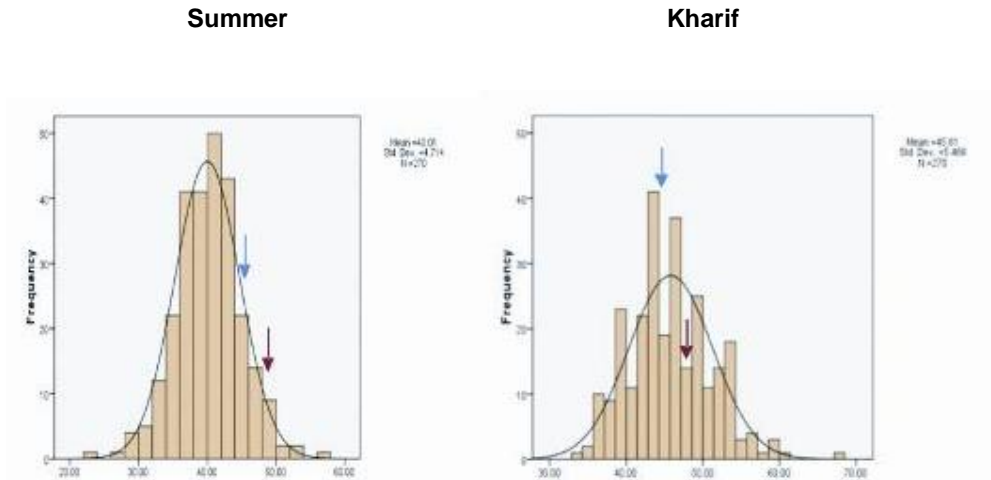


Fig. 14: Frequency distribution of RILs for test weight I in TAG 24 x GPBD 4 population

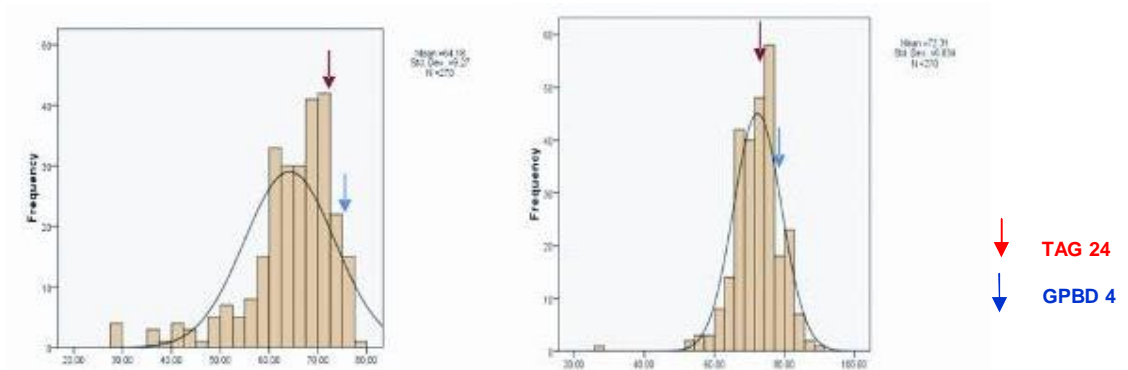


Fig. 15: Frequency distribution of RILs for shelling percentage in TAG 24 x GPBD 4 population

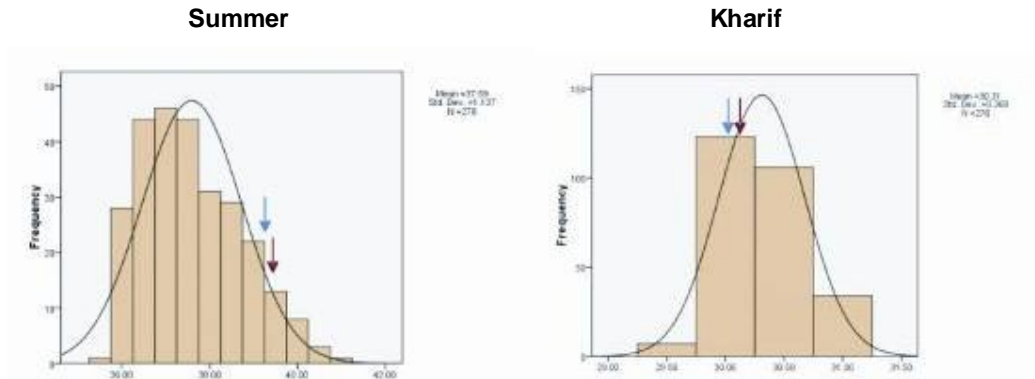


Fig. 16: Frequency distribution of RILs for days to 50% flowering in TAG 24 x GPBD 4 population

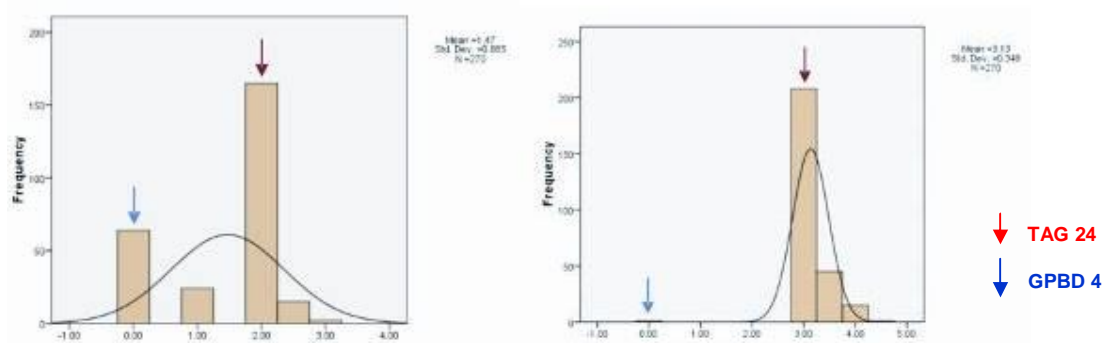


Fig. 17: Frequency distribution of RILs for rust I stage in TAG 24 x GPBD 4 population

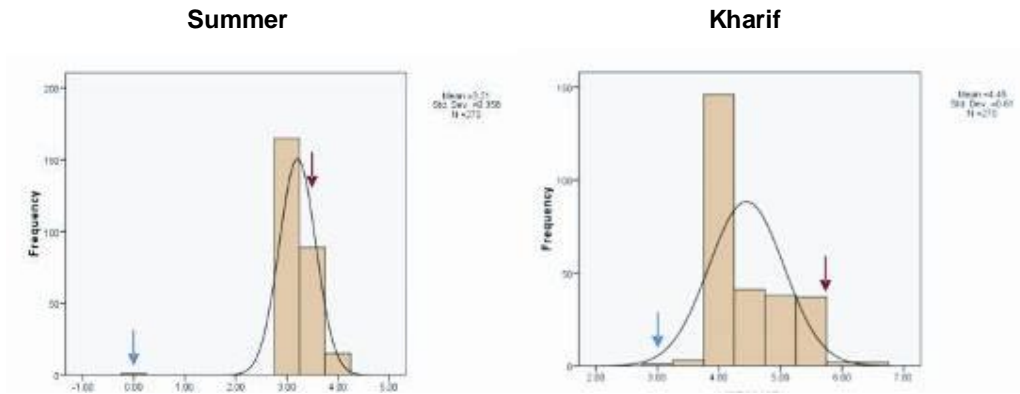


Fig. 18: Frequency distribution of RILs for Rust II stage in TAG 24 x GPBD 4 population

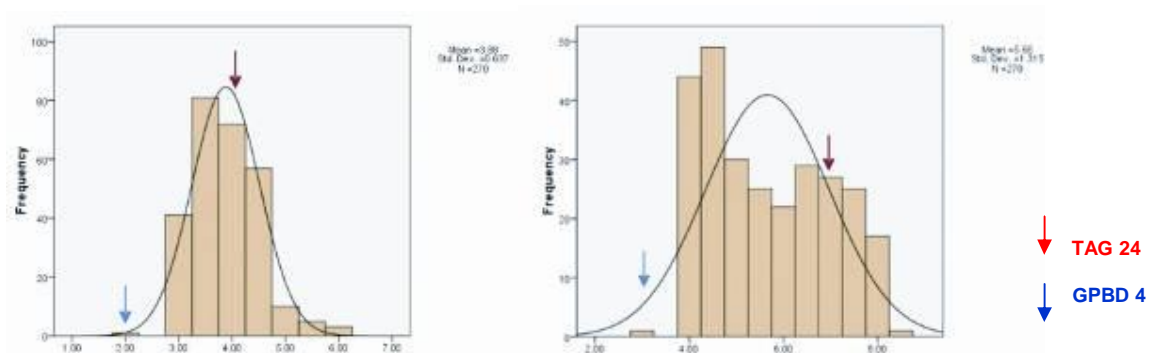


Fig. 19: Frequency distribution of RILs for rust III stage in TAG 24 x GPBD 4 population

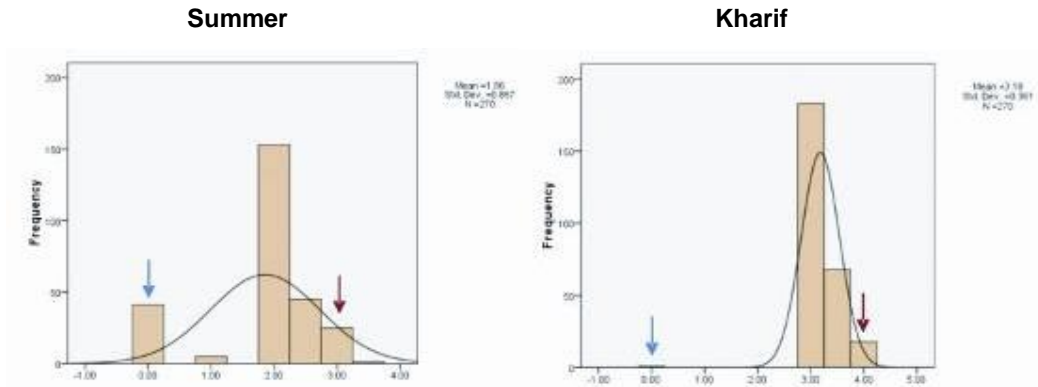


Fig. 20: Frequency distribution of RILs for LLS I stage in TAG 24 x GPBD 4 population

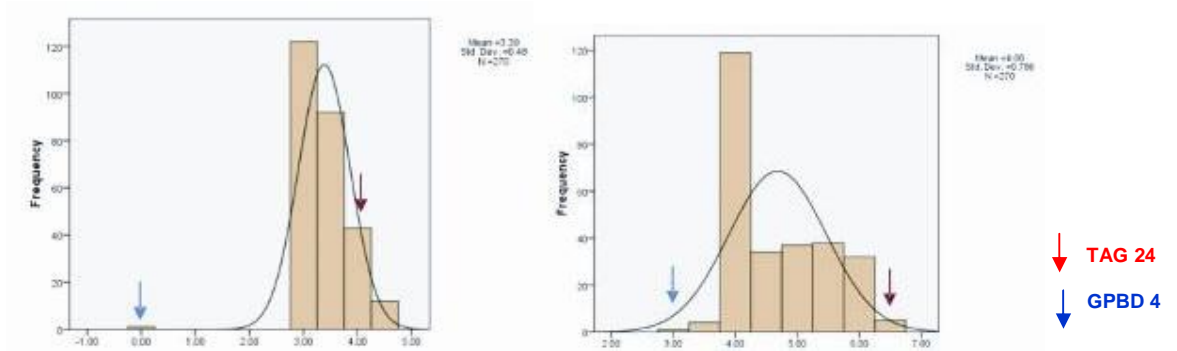


Fig. 20: Frequency distribution of RILs for LLS II stage in TAG 24 x GPBD 4 population

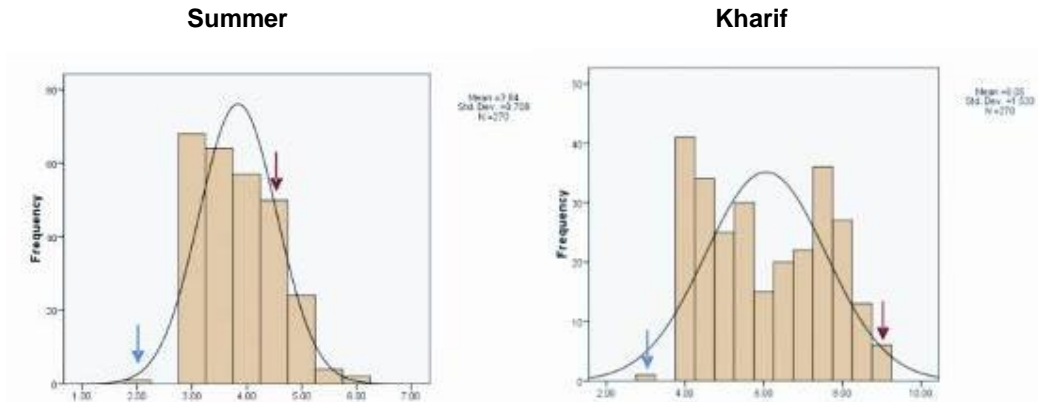


Fig. 22: Frequency distribution of RILs for LLS III stage in TAG 24 x GPBD 4 population

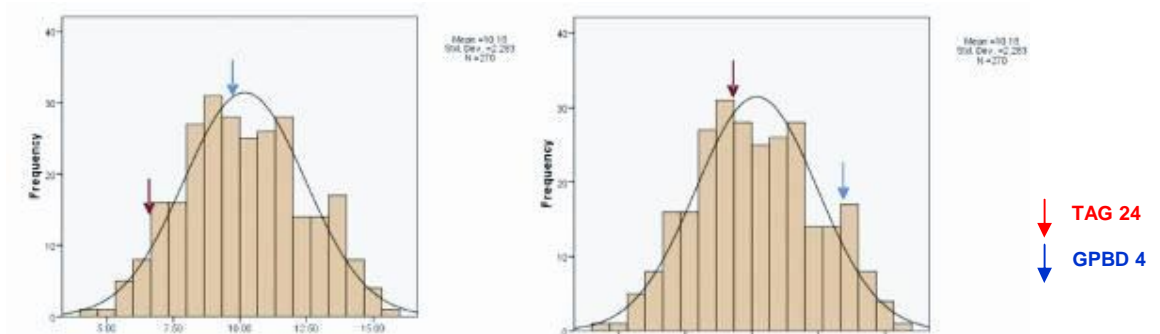


Fig. 23: Frequency distribution of RILs for kernel yield (g/plant) in TAG 24 x GPBD 4 population

Summer

Kharif

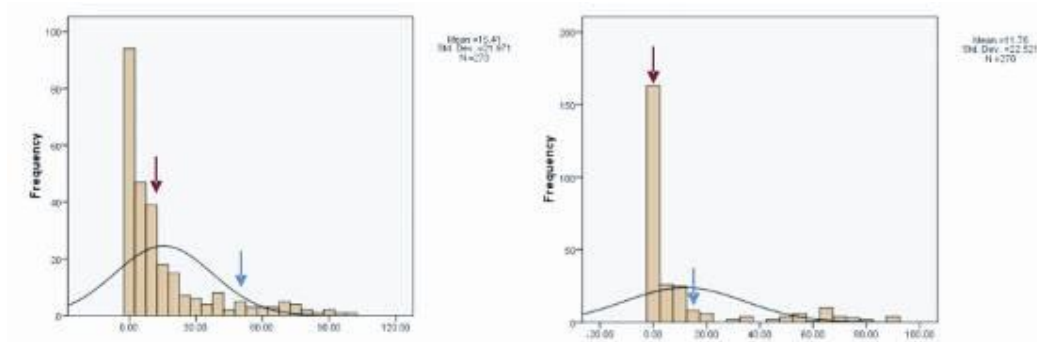


Fig. 24: Frequency distribution of RILs for Intensity of dormancy in TAG 24 x GPBD 4 population

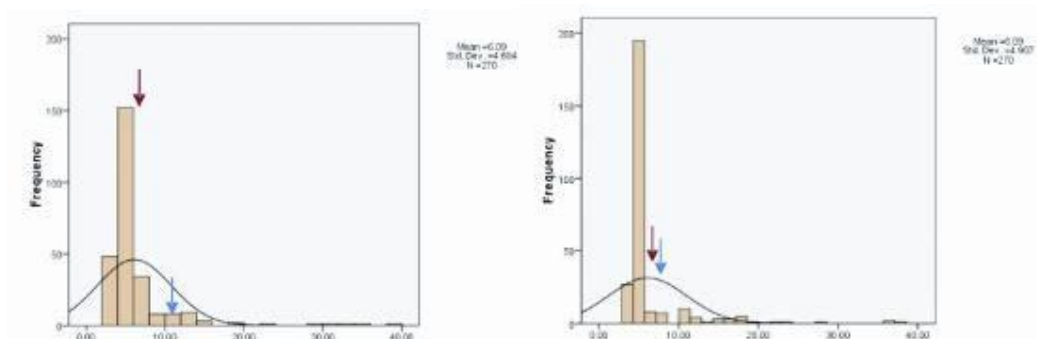


Fig. 25: Frequency distribution of RILs for duration of dormancy in TAG 24 x GPBD 4 population

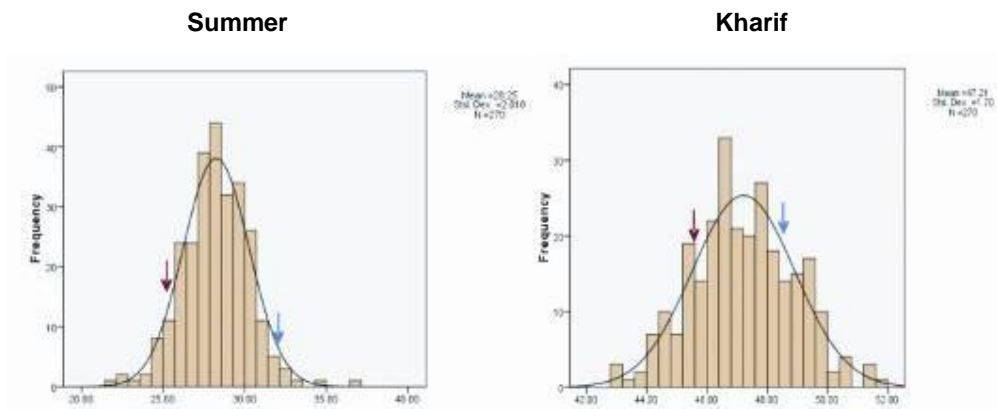


Fig. 26: Frequency distribution of RILs for protein and oil in TAG 24 x GPBD 4 population (*kharif*)

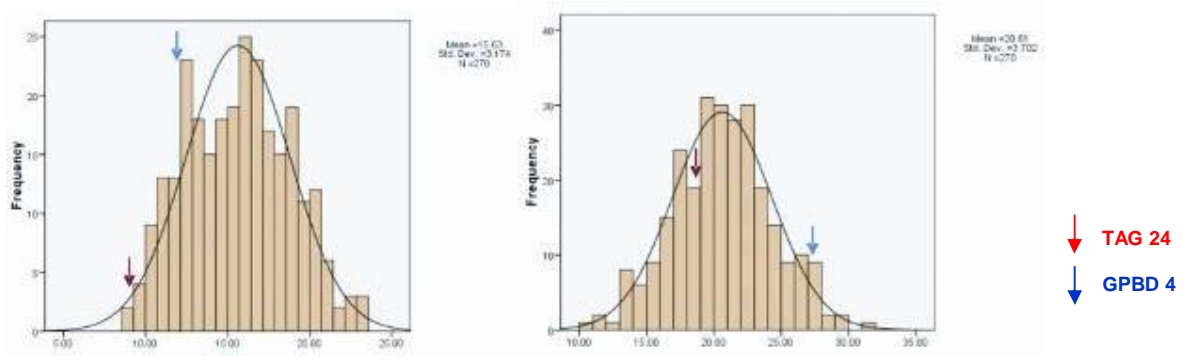


Fig. 27: Frequency distribution of RILs for dry pod yield (g/plant) in TAG 24 x GPBD 4 population

The distribution pattern was normal for all the productivity traits studied in both the seasons. Most of the RILs were falling within the range of parents; however, few RILs were showing transgressive segregation towards both higher (GPBD 4) and lower value (TAG 24) parents for all the traits (Fig. 14, 15, 23 and 27).

Skewed distribution was observed for both intensity and duration of dormancy in both the season towards parent TAG 24 (Fig. 24 and 25).

The frequency distribution for rust was bimodal (stage I in summer) (Fig. 17) to normal (stage II and III in kharif and stage III in summer) (Fig. 19 and 22). The distribution was skewed towards susceptible in *kharif* (stage I and stage II in summer) (Fig. 18 and 20). Majority of the RILs fell within the range of parents.

For late leaf spot, the distribution was mostly normal but skewed towards susceptibility at stage I in *kharif* (Fig. 20) and at stage II in summer (Fig. 18). The distribution was bimodal at stage I in summer (Fig. 17).

Normal distribution was observed for both oil and protein content in *kharif* season with few RILs exhibiting transgressive segregation beyond both higher (GPBD 4) and lower value (TAG 24) parents. More transgressive segregants were observed for oil content compared to a very few for protein content (Fig. 26).

5. DISCUSSION

World wide there is an increased awareness that agricultural practices must be sustainable. Plant breeding has an important role in sustainable agriculture. Duvick (1993) has described the general needs of a sustainable agricultural system and included characteristics needed in cultivars for such a system. These characteristics were included biotic and abiotic stress resistance and adaptation to relatively unmodified soil and climatic conditions.

In India , like in other developing countries groundnut average yield remains well below the levels achieved in the country like USA , where in yields average 2800 to 3400 kg/ha. The low yield in developing countries are due to constraints that vary from place to place and system to system. In almost all situations, biotic and abiotic stresses would reduce the groundnut crop yield, if uncontrolled. Among the abiotic stresses, lack of dormancy in the cultivated genotypes leading to in-situ germination when the matured crop is caught in rains has its own share.

Nearly 70 per cent of the area under groundnut in Karnataka is covered with bunch varieties belonging to subspecies *Arachis fastigata* and *Arachis hypogaea*, which are popular because of their short duration and suitability for easy harvesting. In general, varieties belonging to subspecies *fastigata* are characterized by non-dormancy, while those of subspecies *hypogaea* which possess long periods of seed dormancy. Bunch varieties under cultivation lack seed dormancy and hence germinate *in situ* especially when the crop is caught in rains or affected by foliar disease and *Sclerotium* stem rot, causing heavy losses. Though efforts were made to hybridize between these two subspecies, recovery of desirable segregants with 2 to 3 weeks of dormancy was very low (Wadia *et al.*, 1987, Naidu, 1997, Nautiyal and Bandobadhyay, 2001, Naidu *et al.*, 2003 and Diopt and Faye, 2009). However, in recent years, some of the erect bunch cultivars have been reported to possess varied periods of dormancy after harvest (Hull, 1937; John *et al.*, 1948; Muhammad and Dorairaj, 1968; Lin and Chen. 1970; Reddy *et al.*, 1985; Pandya and Patel, 1986). But these genotypes were poor in productivity, adaptability and other agronomic features (Ashok Kumar, 1989). There is a strong need for hybridization between dormant and non-dormant Spanish bunch cultivars. Knowledge of genetics of a trait helps in improving the efficiency of breeding for the trait following hybridization .Dormancy being a resultant of complex interactions of the parental and the embryonic genotypes and also highly environmentally sensitive, few attempts towards elucidating its inheritance have been inconclusive (Stokes and Hull,1930:John *et al.*,1948 ; Ramachandran *et al.* , 1967 : Lin and Lin ,1971b and Chang , 1972 Naidu, 1997, Nautiyal and Bandobadhyay, 2001 and Naidu *et al.*, 2003).In such a case as, an alternative , an empirical approach on potential response to selection for dormancy besides identification of dormant segregants with other desirable attributes in the segregating generations would be a useful breeding strategy.

In order to alleviate the problem of loss due to *in situ* germination there is a great need to evolve locally adopted, high yielding dormancy bunch cultivars with desirable pod and kernel features. Long period of seed dormancy is also undesirable under situation like using the seeds produced in one season for sowing in the succeeding season, to grow more generations per year, to advance breeding material and to subject the seeds technologists for the seed tests upon harvest. Based on such conflicting requirements, two week period of dormancy has been considered as an optimum period.

The present investigation is an attempt towards systematic evaluation of mapping population for dormancy and other characters over two seasons. The population was generated using ruling non-dormant bunch variety TAG 24 and dormant bunch variety GPBD 4 were evaluated for variability to explore the potentiality of the cross in giving dormant segregants combining other desirable characters.

In this context the generated information on RILs population are discussed under the following headings.

- 5.1 Analysis of yield and its component traits in RIL population
 - 5.1.1 Genetic variability for yield and its component traits
 - 5.1.2 Component of variation, heritability and genetic advance
 - 5.1.3 Disease resistance to rust and late leaf spot
- 5.2 Dormancy in RIL population
 - 5.2.1 Methodology for evaluation for dormancy
 - 5.2.2 Occurrence and extent of dormancy
 - 5.2.3 Nature of dormancy
 - 5.2.4 Frequency of desirable segregants in population

5.1 Analysis of yield and its component traits in RIL population

5.1.1 Genetic variability for yield and its component traits

RILs used in present study were nearly homogzygous and the analysis of variance for different traits revealed highly significant difference among the genotypes, suggesting a high degree of genetic variability in the material evaluated. This could be attributed to use of diverse parents in development of this population. There was variability for yield, yield component traits and dormancy.

RILs were evaluated in two distinct seasons at UAS, Dharwad to understand the effect of season on productivity traits and to know the effect of environment on dormancy related traits and this data from two different locations were analyzed. The critical analysis of mean of RILs indicated that there was no much difference in means of the traits studied in two seasons for productivity traits and dormancy.

Analysis of variance revealed significant variation among the RILs, seasons and also significant G x E interaction for all the traits studied in the populations suggesting the need to screen in multiple seasons/locations. Extensive prevalence of G x E interaction for productivity traits in groundnut was also reported by Wynne and Isleib (1978), Niadu (1997), Swain (2001), Swain (2002) and Naidu (2003).

Frequency distribution for all the productivity traits was mostly normal indicating quantitative inheritance. Transgressive segregants were observed in both the directions for all the traits revealing the contribution of favourable alleles from both the parents.

The most important component of edible groundnut export consists of the bold seeded, hand picked and selected (HPS) types, which have great demand all over the world and fetch higher prices in domestic and international markets. In India, groundnut trade is restricted to hand picked selected kernels in the absence of genotypes with large kernels and good quality (Chandrashekhara, 1991 and Dwivedi and Nigam, 1995). Existing large seeded genotypes lack disease resistance and the emphasis is on incorporation of multiple disease resistance. The cross involving TAG 24 was superior for seed size as revealed higher seed size. Hence, the cross was analyzed for lines with 100-seed weight combining disease resistance. Since varieties with hundred seed mass of 60g or more are considered as large seeded groundnut which are preferred for confectionery purpose, RILs exceeding 60g seed weight were compared with the parents. Only two lines (No.19 and 233) in *kharif* with moderate resistance to rust and LLS and having large seed size coupled with higher yield were observed. None of the lines combined multiple disease resistance. This suggests there is need for large population size to get better segregants (Sarala and Gowda, 1998 and Reddy, 2004) or through intermating among the selected lines. Selected lines could be evaluated in large scale trials for their suitability in commercial cultivation and future breeding programmes to combine multiple stress resistance.

The resistant germplasm lines belonging to Virginia or Valencia land races, suffer from poor agronomic features. Early maturing Spanish bunch cultivars are popular because of ease in cultivation and harvesting but are susceptible to most of the biotic and abiotic stresses. Same trend was observed in the present study.

5.1.2 Component of variation, heritability and genetic advance

Effectiveness of selection depends on the extent of genetic variability for trait of interest. Hence, it is necessary to study the variability in respect of quantitative characters with reference to genetic parameters such as genotypic variance, phenotypic variance, heritability and genetic advance.

The difference between PCV and GCV was more for yield and yield component traits in each the season. This indicated the prevalence of the environmental influence on the expression of these traits. However, the effect of environment on the duration of dormancy, kernel yield and dry pod yield (g/plant) was little low as indicated by the narrow difference between the phenotypic and genotypic coefficient of variation for each trait studied. Among productivity traits, hundred kernel weight, shelling percent, sound mature kernel and intensity of dormancy recorded little wider difference between PCV and GCV indicating the role of environment on the expression these traits. There was a low genotypic coefficient of variation for days to 50 per cent flowering and protein content, indicating lack of genetic variability for these traits and as parents also had less variation for these traits. This kind of discrimination between different characters from being influenced by external factor may be attributed to the difference in their genetic effects. Those which showed more difference at phenotypic and genotypic level may have more of additive gene effects than dominance and epistatic gene effect (Singh *et al.*, 1996, Mather and Manivel, 2000, Jatti *et al.*, 2008, John *et al.*, 2009 and Kavera, 2008).

In present study, genotypes consisted recombinant inbred lines advanced to F₁₁ generation, hence all were expected to be homozygous. Thus, for the prediction of response to selection it is apt to use broad sense heritability because the entire genotypic values are transmitted to the progeny when any selection is advanced through selfing. The results of genetic advance hold good as long as selection is practiced between the lines. The results of present study on heritability for yield and yield component traits suggested that except days to 50 per cent flowering and sound mature kernel in *kharif* season and sound mature kernel and hundred kernel weight in summer season, all characters studied had moderate to high heritability. Whereas, protein, oil, intensity and duration of dormancy recorded high heritability, the estimates of genetic advance over mean suggested that real progress could be made for 100 kernel yield, kernel yield per plant, dry pod yield per plant, intensity and duration of dormancy. This also indicated that these traits are mainly under the control of additive genes. Whereas, the traits like days to 50 per cent flowering, shelling percentage, oil content, sound mature kernel and protein content had profound influence of non-additive effects. According to Panse (1957) if heritability is mainly due to non-additive effects, the genetic advance will be low, whereas if the heritability is due to additive effects it would be associated with high genetic advance.

5.1.3 Disease resistance to rust and late leaf spot

Genetic studies on LLS and rust revealed that resistance is mostly controlled by recessive genes thus necessitating more generations and large populations to identify resistant segregants (Nevill, 1982 and Kalekar *et al.*, 1984). Further, when the diseases occur together they interfere with each other and LLS dominates rust leading to difficulties in identification of resistant lines to these diseases (Subramanyam *et al.*, 1984). Occurrence of these diseases is irregular most of the time. Transfer of resistance to these diseases from land races and wild relatives to cultivated background is difficult due to linkage drag, *viz.*, undesirable traits like thick shell, low yield, poor adaptability and long duration are associated with resistance (Singh *et al.*, 1997).

The ANOVA showed significant variation for rust and LLS in both the seasons. Significant seasonal and genotype x season interaction indicated the need for screening in multiple environments. In earlier studies also, the significant role of G x E interaction in conditioning the reaction of RILs to these two diseases were reported (Narasimhulu, 2007, Khedikar, 2008 and Sarvamangala, 2009).

The components of variation, *viz.*, PCV and GCV revealed substantial variation for both the diseases (Table 9). Further, moderate to high heritability and GAM indicated highly heritable nature of the variation.

The pattern of distribution of RILs was mostly bimodal for rust and normal for LLS in both the populations, indicating possibility of simple inheritance with few genes for rust as compared to complex nature of inheritance for LLS. Wide distribution indicated good segregation for both the diseases. The distribution of RILs was mostly within the range of parents for both LLS and rust in both the populations indicating the possible contribution of resistance mostly by only one of the parents.

Only a few RILs exhibited high level of resistance to both the diseases. 65 for rust and 55 RILs for LLS exhibited resistance to both rust and LLS, respectively at stage I in summer. But, none of the RILs exhibited high level of resistance to both the diseases at stage II and stage III in the populations.

5.2 Dormancy in RIL population

5.2.1 Methodology for evaluation for dormancy

The dormancy is one of the highly developmentally unstable and environmental sensitive character, besides it is a physiological transient stage of the seeds (Naylor *et al.*, 1979) and often less amenable for quantification. Further the dormancy in groundnut lacks definite periodicity and is a feature of the individual kernel rather than that of the whole plant, because of asynchronous pod development and maturity. Hence there is a need to adopt an appropriate methodology to assess relative dormancy among different genotypes. In the present investigation since the germination tests were conducted at weekly intervals after harvest, two parameters were considered to interpret the dormancy. The germination percentage at seven days after harvest was taken as an indicator of intensity of dormancy. While the days taken to obtain 50 per cent germination as estimated by probit method represented the duration of dormancy.

5.2.2 Occurrence and extent of dormancy

The RILs which have shown less than 70 per cent germination at first germination test on seven day were considered as dormancy. Based on this criteria bunch varieties GPBD 4 found to be dormant and TAG 24 found to be non dormant. Out of 268 lines, 41 lines during Kharif and 52 lines during summer were found to be dormant by showing less germination percentage (70 per cent). The experiments on germination for two seasons have shown cultures *viz.*, RIL no. 40, 79, 84, 165, 183, 209, 213 and 259 found to be dormant. When intensity of dormancy is considered the RIL no. 165, 259, 160, 172, 209, 254, 213, 247, and 248 recorded very high values above 70 per cent in two seasons. While RIL no. 84, 89, 110, 195, 257 and 267 fluctuated widely for intensity of dormancy over seasons.

The variation for dormancy in terms of duration as revealed by G 70 estimates was subsequently large as compared to the intensity of dormancy among 268 dormant RILs. The RIL no. 5, 40, 84, 165, 183, 209, 213, 248, 254, 259 and 265 were found to have more than two weeks of dormancy (G 70) in all the two seasons. A period of 2-3 weeks of dormancy was exhibited by RIL no. 5, 30, 40, 84, 110, 165, 183, 219 and 267 during Kharif and RIL no. 5, 40, 84, 89, 165, 172, 267 and 183 during summer. While, that was a wide fluctuation for G 70 in RIL no 11, 23, 30, 91, 95 and 103. The RIL no 9 exhibited weak dormancy by having a G 70 2.84 days during summer. Variation in the periods of dormancy from year to year has been reported by several workers (John *et al.*, 1948; Gavrielith, 1962; Gautreau, 1984, in case of groundnut and Fukuyuma *et al.*, 1973, Vonka and Bosak, 1975, Naidu, 1997, Nautiyal and Bandobadhyay, 2001, Swain, 2001, Naidu *et al.*, 2003 and Dipt and Faye, 2009). Variations in the periods of dormancy in groundnut is because of seasonal fluctuations in the environmental factors, which affect the dormancy by their influence on mother plant and on seeds during post harvest storage (Hull, 1937; John *et al.*, 1948; Toole *et al.*, 1956; Bailey *et al.*, 1958; Mcfarland and Smith, 1966, Naidu, 1997, Swain *et al.*, 2001, Swain *et al.*, 2002, Naidu *et al.*, 2003, Asibuo *et al.*, 2008 and Faye *et al.*, 2010). Further, the occurrence of foliar diseases in the field often leads to defoliation and subsequent breakage of dormancy period of seeds.

Among lines studied, RIL no 213, the dormant genotype matured early in both the seasons but suffered with low dry pod yield and hundred kernel weight in summer. RIL no 267 and 209 yields comparable to GPBD 4 with more than 3 weeks of dormancy and high intensity during *kharif* but suffers with small seed size as revealed by low hundred kernel weight and yield during summer. RIL no 183 found better for dry pod yield per plant (DPY) and 100 kernel weight (HKW) but matures late as revealed by more number of days taken to flowering during summer and less intensity and duration of dormancy in both seasons. By the above discussion it is evident that ruling erect bunch varieties are superior for productivity parameters but lack dormancy, while as dormant genotypes lack in one or more productivity parameters, viz., DPY, SP and HKW. No genotype exhibited superiority for combination of characters. Thus selected lines with desirable traits have to be used to generate crosses for evaluation of variability, association of dormancy with other characters, response to different selection schemes as well as their potentiality to give dormant segregants with other desirable characters.

5.2.3 Nature of dormancy

Basically two principal types of seed dormancy have been identified in plants. They are embryo dormancy where control resides within the embryo and seed coat imposed dormancy wherein the control resides in the seed coat (Bewly and Black, 1985).

Germinability of dormant seeds upon removal of seed coat provides a good test for existence of seed coat imposed dormancy (Barton, 1965). In the present investigation, nine and six dormant lines were subjected to such a test in both seasons and the results revealed that two lines, GPBD 4 and RIL no 5 during *kharif* and four lines, RIL no 40, 84, 209 and 213 during summer have distinctly without seed coat imposed dormancy with 70 per cent germination.

On the other hand, other dormant lines have shown varied degree of improvement in germinability. Seed coat induced dormant line 209 and 213 during summer recorded more than 80 per cent germination upon seed coat removal in *kharif* indicating effect of environment and required extensive investigation. Improvement in germination percentage upon seed coat removal in groundnut was observed by Toole *et al.* (1964), Patil (1967), Ashok Kumar *et al.* (1989) and Nautiyal and Bandobadhyay (2001). Negative effects of seed coat extracts of dormant cultures on germinability and root growth of non dormant cultures was observed by Vaithialingam and Rao (1973a) and Joshi *et al.* (1980).

5.2.4 Inheritance pattern of dormancy in RILs of TAG 24 (GPBD 4

In the RILs population TAG 24 (GPBD 4, the ratio of dormant to non dormant seeds at 14 days after harvest (<70%) fitted in the ratio of 15:1 (non dormant : dormant), which confirms that dormancy is controlled by duplicate recessive gene. These results differ from Upadhaya and Nigam (1999), Asibuo *et al.* (2008) and Fayeissa *et al.* (2010) who observed that complete dominance is controlling dominance in F₂ population derived from true F₁ hybrids.

5.2.5 Frequency of desirable segregants in population

Though magnitude of variation and mean performance of the mapping population indicate the potential segregants available for selection, the ultimate worth of the cross can be judged by the superiority of the segregants available for selection, over existing variety for the characters under consideration.

In general high frequency of segregants (100.00%) were obtained for days to 50 percent flowering (Fig. 28) whereas, less frequency of segregants (<13.00%) were obtained for dormancy in both seasons. Earlier literature showed very low frequency of segregants (<24.5%) for dormancy in intersubspecific crosses (Wadia *et al.*, 1987; Sarala, 1993 and Diddimani, 1996). Wynne and Halward (1989) after extensive review opined that fewer genes in the crosses with closely related parents (within botanical types) and more genes in the crosses with distant parents (different botanical types) control the expression of different traits, leading to varied proportion of alternate types in different crosses.

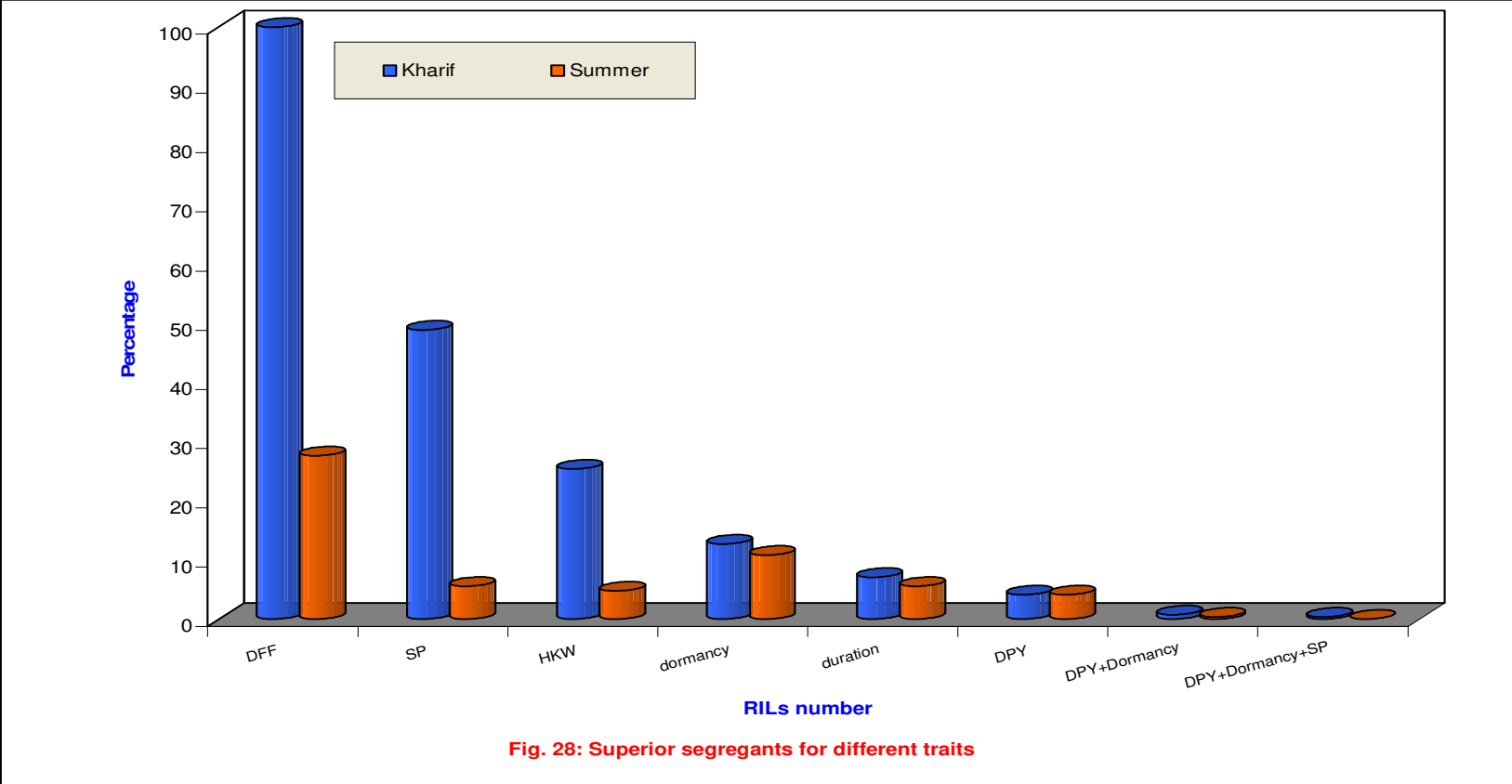


Fig. 28: Superior segregants for different traits

Fig. 28: Superior segregants for different traits

For the most important productivity parameters DPY a less number of superior segregants (4.10%) were recovered. Diddimani (1996), had recorded higher frequency of both numerically and significantly superior segregants (71.1 and 13.3%) for DPY in crosses involving Spanish bunch and interspecific derivatives indicating higher potential of intersubspecific crosses.

The frequency of segregants for duration of dormancy (G 70) was very low (<10%) in both seasons. The frequency of segregants for SP and HKW was higher in kharif than summer. When more characters were considered along with dormancy, the frequency of segregants reduced further. For example, frequency of segregants for DPY, SP and dormancy and DPY and dormancy were less than 1 per cent in both seasons. This problem can be avoided by raising large population or resorting to intermating of selected segregants to increase dormant segregants combined with other desirable attributes.

Future line of work

1. Dormancy is highly plastic in nature because of complexity of its expression and its high environmental sensitivity. Transient nature of this trait has led to ineffective selection and hence need arises to identify some marker for easy and early generation selection. In the present investigation, an effort was made to know the association of dormancy with seed coat and some of the other characters but there was no such association. Further the enzymes cathodic esterase, anodic esterase and acid phosphatase zymograms were known to differ between germinating and ungerminated seeds (Cherry and Ory, 1973). Hence, future studies should be directed towards identifying biochemical (Isozyme)/Molecular (DNA) markers associated with dormancy to make the selection more effective.
2. In the present investigation many superior segregants combining dormancy and other desirable attributes were obtained among the various RILs. But their frequency was less. Hence, efforts should be directed towards further evaluation of selected lines in large scale trials for releasing as cultivar or selective intermating should be taken up to improve the lines for desirable attributes under recurrent selection cycles.
3. An investigation to find out the association of dormancy with easily identifiable morphological characters such as foliage colour, branching pattern, number of branches per plant etc and their suitability as indirect parameters of selection for dormancy will be useful for practical plant breeding.
4. In the present investigation genotype with seed coat imposed dormancy have been identified but no such embryo controlled have been identified. Studies on physiological basis of these two types of dormancies can be taken up.

6. SUMMARY AND CONCLUSIONS

An investigation to assess the genetic potential of some of the selected dormant bunch cultivars for improvement of groundnut (*Arachis hypogaea* L.) was started in summer and *kharif* 2010 at Main Agricultural Research Station, Dharwad. A total of 268 lines were evaluated for nature and extent of dormancy, yield components, pod and kernel features and they were studied for two seasons.

A total of 268 lines of TAG 24 × GPBD 4 mapping population were evaluated for the experiments on germination test over two seasons at different stages revealed that 49 and 42 lines (at 7 DAH), 16 and 22 lines (at 14 DAH), 6 and 7 lines (At 21 DAH) and 5 and 4 lines (at 28 DAH) to be dormant during summer and *kharif*, respectively.

Among these, high intensity of dormancy was observed for RIL number 165, 208, 160, 202, 213 and 259 in both the season. While, the line number 84, 89, 110, 195, 257 and 267 fluctuated widely for intensity of dormancy. The line RIL number 40, 84, 209, 213 and 259 were found to have more than three weeks of dormancy (G 70) in both seasons, respectively. While RIL number 11, 23, 30, 91, 95 and 103 fluctuated widely for duration of dormancy across the seasons.

The RIL lines number 5, 40, 84, 209, 213 and GPBD 4 distinctly have seed coat imposed dormancy, some of the RIL line number 208 and 213 during summer improved germination upon seed coat removal.

Analysis of variance revealed significant variation among the RILs, seasons and also significant G × E interaction for all the traits studied in the populations suggesting the need to screen in multiple seasons/locations. The heritability for yield and yield component traits suggested that except for days to 50 per cent flowering and sound mature kernel in *kharif* season and sound mature kernel and hundred kernel weight in summer season, all characters studied had moderate to high heritability. Whereas, protein, oil, intensity and duration of dormancy recorded high heritability.

The study has given evidence that for seed dormancy in this mapping population is controlled by duplicate recessive area.

The frequency distribution of genotypes for oil, protein, dormancy related traits, yield and yield component traits in RILs, population was normal indicating polygenic inheritance. Transgressive segregants observed in both the directions indicated the contribution of favourable alleles from both the parents.

In general high frequency of segregants (100.00%) were obtained for days to 50 per cent flowering whereas, less frequency of segregants (<13.00%) were obtained for dormancy in both seasons. For the most important productivity parameters DPY a less number of superior segregants (4.10%) were recovered. The frequency of segregants for duration of dormancy (G 70) was very low (<10%) in both seasons. The frequency of segregants for SP and HKW was higher in *kharif* than summer. When more characters were considered along with dormancy, the frequency of segregants reduced further. For example, frequency of segregants for PY, SP and dormancy and DPY and dormancy were less than 1 per cent in both seasons (Fig. 27). This problem can be avoided by raising large population or resorting to intermating of selected segregants to increase dormant segregants combined with other desirable attributes. Among lines studied, RIL no 213, the dormant genotype matures early in both the seasons but suffers with low pod yield and hundred kernel weight in summer. RIL no 267 and 209 yields comparable to GPBD 4 with more than 3 weeks of dormancy and high intensity during *kharif* but suffers with small seed size as revealed by low hundred kernel weight and yield during summer. RIL no 183 found better for DPY and HKW but matures late as revealed by more number of days taken to flowering during summer and less intensity and duration of dormancy in both seasons. No genotype exhibited superiority for combination of characters.

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* Originals not seen _____

Appendix I: Monthly meteorological data during crop growth period (2009-10) and the average of 59 years (1950-2009) at Main Agricultural Research Station, UAS, Dharwad

Months	Rainfall (mm)		Temperature (°C)				Relative humidity (%)	
	2010-11	1950-2009	Mean maximum		Mean minimum		2010-11	1950-2009
			2010-11	1950-2009	2010-11	1950-2009		
April	43.8	39.0	36.5	36.0	21.1	20.1	81.0	78.0
May	63.1	68.0	35.5	34.4	21.5	20.9	84.0	75.6
June	63.4	107.9	30.3	28.8	20.9	21.7	77.0	86.4
July	155	136.7	26.0	28.7	20.9	20.9	88.0	89.2
August	190.7	155.8	28.1	26.9	20.6	20.1	80.0	88.7
September	164.9	133.6	28.5	28.2	20.7	19.9	83.0	86.8
October	177	93.6	29.3	30.2	18.8	18.7	65.0	79.7
November	92.8	52.6	28.6	29.7	18.0	15.9	69.0	73.7
December	0.6	2.6	28.8	28.9	15.4	13.2	66.0	69.3
January	0.8	0.05	28.2	29.7	15.5	13.9	63.0	64.9
February	0.4	0.5	32.4	32.2	17.3	16.5	50.0	54.5
March	0	15.6	35.6	33.7	20.3	19.7	49.0	64.5
Total	908.7	806.2						

Appendix II: Character mean of RIL population during summer

	DFF	Rust@ 70	LLS@ 70	Rust@ 80	LLS@ 80	Rust@ 90	LLS@ 90	HKW (g)	SP (%)	SMK (%)	KY (g/plant)	DPY (g/plant)	DPY (kg/ha)	Intensity of dormancy	Duration of dormancy
1/1-1	36.50	2.00	2.00	3.00	3.00	3.50	4.50	41.00	66.00	84.18	6.41	9.69	1251.74	0.00	4.52
2/2-1	36.00	0.00	2.00	3.00	3.00	4.00	3.50	43.00	67.75	92.89	6.60	9.74	1109.05	5.00	3.44
3/3-1	37.50	2.00	2.00	3.00	3.00	3.50	3.00	43.00	51.50	72.22	8.65	16.95	1577.63	20.00	3.14
4/4-1	37.50	3.00	2.00	3.00	3.00	4.00	3.00	34.00	50.00	71.33	8.26	16.57	1563.97	0.00	4.52
5/5	36.50	2.00	2.00	3.00	4.00	3.50	4.50	42.50	62.25	80.57	8.71	14.01	1580.69	50.00	17.22
6/6	36.00	2.00	2.00	3.00	3.00	3.50	4.00	48.50	71.50	91.08	8.41	11.78	1371.16	0.00	4.52
7/7-1	36.50	0.00	0.00	3.50	3.50	3.50	4.00	27.23	35.61	69.44	4.06	11.41	1607.87	10.00	4.52
8/8-2	36.50	2.00	2.00	3.00	3.50	4.50	4.50	33.00	52.00	71.82	6.68	12.83	1515.06	0.00	4.52
9/9	36.00	2.00	0.00	3.00	3.50	4.50	4.50	45.00	66.75	81.95	11.54	17.34	1458.46	15.00	2.84
10/10-1	36.50	2.00	0.00	3.00	3.50	4.50	4.00	31.50	49.75	65.65	5.96	11.98	1648.23	0.00	4.52
11/11-1	37.00	1.00	2.00	3.00	3.50	4.00	4.50	38.00	44.75	75.40	6.25	13.96	1457.30	50.00	11.26
12/13-1	37.00	0.00	2.00	3.00	4.00	3.00	4.00	36.00	50.00	64.74	8.47	16.95	1735.26	0.00	4.52
13/14-1a	37.00	2.00	2.00	3.00	3.00	3.50	3.50	44.50	64.50	81.09	10.11	15.73	2467.29	0.00	4.52
14/14-2	37.00	2.00	2.50	3.00	3.00	4.00	4.50	37.98	57.50	78.00	7.14	12.44	1752.61	10.00	4.52
15/15	39.00	0.00	2.00	3.00	3.50	4.00	3.50	41.50	52.00	73.00	6.38	12.34	1776.40	10.00	4.52
16/16	40.50	2.00	2.50	3.00	3.00	5.00	4.00	41.00	66.50	89.22	7.24	10.87	1296.26	0.00	4.52
17/17-a	39.50	0.00	0.00	3.00	3.00	4.00	4.50	41.00	69.25	93.16	11.85	17.06	1823.74	20.00	6.30
18/18	40.50	2.00	2.00	3.00	3.00	4.50	4.50	39.50	66.25	89.56	9.00	13.58	1964.89	0.00	4.52
19/19	41.00	0.00	0.00	3.00	3.00	4.00	3.50	37.02	45.00	85.23	4.82	10.70	1442.04	0.00	4.52
20/20-1	36.00	1.00	2.00	3.00	3.50	4.00	4.50	50.00	60.50	76.48	6.84	11.31	1783.55	20.00	6.30
21/21	36.00	2.00	2.50	3.00	3.50	3.50	4.50	48.50	70.75	85.71	8.84	12.45	1545.54	0.00	4.52
22/22A	36.00	2.00	2.00	3.00	3.00	3.00	3.50	52.76	62.33	61.86	11.18	18.03	1871.45	10.00	4.52
23/23-2	36.00	2.00	2.00	3.50	3.00	4.00	3.50	40.50	51.50	85.56	5.73	11.05	1506.55	40.00	11.02
24/24-1	36.00	2.00	3.00	3.00	4.00	4.00	6.00	37.00	62.75	87.72	14.47	23.50	1860.93	5.00	3.44
25/25	38.50	2.00	2.00	3.00	3.00	3.50	3.50	36.50	56.00	86.86	8.18	14.62	1541.39	25.00	6.25
26/26-1	37.00	2.00	3.00	3.00	4.50	4.00	5.00	36.50	61.25	72.62	9.70	15.80	1805.51	0.00	4.52
27/26-2	37.00	0.00	2.00	3.00	4.00	4.00	4.00	37.50	72.75	87.63	9.34	12.85	1495.13	5.00	3.44
28/26-2b	37.50	2.00	1.00	3.00	3.50	4.00	4.00	35.50	60.50	85.42	9.96	16.45	1752.48	5.00	3.44
29/27-1a	36.50	0.00	2.00	3.00	3.50	4.00	4.50	40.50	51.00	77.86	9.19	18.00	2103.87	5.00	3.44
30/27-2	36.50	1.00	3.00	3.00	4.00	4.00	5.00	44.00	61.25	90.95	11.75	19.17	1849.35	20.00	4.81

31/28-2	36.00	2.00	2.00	3.00	3.50	3.50	3.50	38.50	66.50	83.57	9.38	14.11	1751.80	5.00	3.44
32/30-1	36.00	2.00	2.00	3.00	3.50	4.00	4.50	35.00	70.75	91.15	10.68	15.10	1949.63	0.00	4.52
33/34-1	36.00	1.00	2.50	3.50	4.00	5.00	4.50	45.00	69.25	90.77	12.36	17.85	1811.02	10.00	4.52
34/35	37.50	2.00	2.00	3.00	3.50	3.50	4.00	39.50	69.50	90.82	13.05	18.76	1343.23	15.00	5.66
35/36	39.50	3.00	3.00	3.50	3.50	5.00	3.50	39.50	63.00	72.75	9.65	15.29	1426.53	5.00	3.44
36/38	36.50	2.00	3.00	3.00	3.50	3.50	4.00	46.00	63.50	82.44	10.12	15.92	1932.80	0.00	4.52
37/39-2	36.00	0.00	0.00	3.50	4.00	4.50	5.00	39.00	58.50	86.76	11.98	20.48	1929.97	10.00	4.52
38/41-2	36.00	2.00	3.00	3.50	3.50	4.50	5.00	46.00	62.50	75.36	8.88	14.26	1747.21	10.00	4.52
39/42	36.50	1.00	2.00	3.00	3.00	4.00	4.50	41.50	64.00	85.77	10.52	16.43	1275.05	0.00	4.52
40/43-1	36.00	2.00	2.50	3.50	4.00	4.50	5.00	36.50	59.75	92.72	8.69	14.51	1402.54	60.00	38.21
41/44	36.50	2.00	2.50	3.00	3.50	5.00	4.00	45.00	69.75	90.51	8.02	11.50	1331.63	10.00	4.52
42/45-3	36.00	2.00	2.00	3.00	3.00	3.50	3.50	42.50	59.00	89.07	7.34	12.48	1532.13	5.00	3.44
43/46-1	38.50	2.00	3.00	3.00	3.00	3.50	3.50	40.50	63.00	87.15	7.72	12.28	1700.48	0.00	4.52
44/47-1	37.50	2.00	2.00	3.00	3.50	3.50	4.50	46.50	70.50	79.10	11.70	16.57	2194.88	0.00	4.52
45/48	38.00	1.00	2.00	3.00	3.50	3.00	3.50	40.50	63.75	87.07	9.90	15.50	1710.66	15.00	5.66
46/49	36.00	2.00	2.50	3.50	3.50	3.50	4.00	33.50	60.75	81.90	9.90	16.31	1671.79	30.00	7.73
47/50-2	36.50	0.00	2.50	3.50	3.50	3.50	4.50	45.00	71.75	83.81	10.12	14.12	1958.84	5.00	3.44
48/51	36.50	2.00	2.00	3.00	3.00	4.50	3.50	42.00	73.50	90.46	7.54	10.25	1587.69	55.00	9.56
49/52-2	36.00	0.00	2.50	3.00	3.00	3.50	4.50	41.00	65.50	84.99	10.49	16.04	1499.52	15.00	5.66
50/53	36.50	2.00	2.50	3.00	3.50	4.00	4.50	38.00	68.25	89.75	8.65	12.76	1159.72	5.00	3.44
51/55	36.50	2.00	2.00	3.00	3.50	4.50	3.00	39.50	70.25	83.99	9.04	12.86	1868.11	20.00	6.30
52/56-2	36.00	0.00	2.00	3.00	3.00	3.50	3.00	38.00	68.50	73.46	8.70	12.78	1530.21	0.00	4.52
53/57	36.50	1.00	2.00	3.00	3.00	4.00	3.00	35.50	64.25	82.41	7.45	11.61	1726.69	20.00	6.30
54/60-1b	36.50	2.00	2.00	3.00	3.00	4.00	3.00	34.50	68.75	81.91	10.55	15.31	1699.50	15.00	5.66
55/62	37.00	2.00	2.00	3.00	3.00	3.00	3.00	42.18	74.03	80.84	8.27	11.18	1825.80	5.00	3.44
56/63	36.00	2.00	2.00	3.00	3.50	4.00	3.00	45.50	60.50	89.71	9.56	15.74	1619.82	15.00	5.66
57/64-1	36.50	2.00	2.00	3.00	3.00	4.50	3.00	35.25	62.07	75.59	8.48	13.63	2009.23	0.00	4.52
58/65	37.00	2.00	2.00	3.00	3.00	3.50	3.00	48.98	57.50	81.52	12.74	22.14	1816.09	0.00	4.52
59/68	38.50	0.00	0.00	3.00	3.00	3.50	3.00	37.50	63.00	94.15	13.93	22.15	2281.37	0.00	4.52
60/69	37.50	0.00	0.00	3.00	3.00	3.50	3.00	38.38	72.75	92.22	11.68	16.05	1427.25	0.00	4.52
61/70-2	37.50	0.00	2.00	3.00	3.00	3.00	3.00	42.41	63.42	86.43	7.86	12.33	1649.70	0.00	4.52
62/71-1	40.00	0.00	0.00	3.00	3.00	3.00	3.00	37.00	62.50	86.12	8.47	13.53	1528.11	10.00	4.52
63/72-1	39.00	2.00	2.00	3.00	3.00	3.00	3.00	47.41	70.00	85.75	9.23	13.17	1822.79	0.00	4.52
64/73-1	39.00	1.00	0.00	3.00	3.00	4.00	3.00	33.24	73.50	91.94	10.33	14.11	1334.26	25.00	6.71
65/76-1	36.50	2.00	0.00	3.00	3.00	3.00	3.00	41.00	62.25	85.74	8.36	13.55	1740.96	5.00	3.44

66/77-1	38.00	1.00	0.00	3.00	3.00	3.00	3.50	35.00	60.75	76.14	9.33	15.41	1655.23	0.00	4.52
67/78-2	38.00	1.00	0.00	3.00	3.00	4.00	3.00	38.50	68.75	77.84	13.35	19.41	1773.37	20.00	6.30
68/79	38.00	0.00	0.00	3.00	3.00	3.50	3.00	41.00	70.50	90.36	10.89	15.42	2130.68	0.00	4.52
69/80-1	38.00	2.00	0.00	3.00	3.00	3.50	3.00	42.00	61.00	92.83	7.26	11.81	2154.32	0.00	4.52
70/81	37.50	0.00	0.00	3.00	3.00	4.00	3.00	46.50	73.50	91.79	11.72	15.95	1977.76	20.00	6.30
71/82a	37.00	2.00	2.50	3.00	4.00	3.50	4.00	41.00	69.25	80.10	10.40	15.00	1738.75	5.00	3.44
72/83-1	37.50	2.00	2.00	3.00	3.00	3.50	3.00	29.00	67.50	84.73	11.14	16.64	1834.27	50.00	8.00
73/84-1	38.50	0.00	2.50	3.00	4.00	3.50	4.00	36.50	72.25	81.97	7.28	10.05	1283.08	10.00	4.52
74/85-1	40.00	2.00	0.00	3.00	3.00	3.00	3.00	32.50	76.75	82.17	12.01	15.63	1527.98	0.00	4.52
75/87	40.00	1.00	2.50	3.00	3.00	3.50	3.50	32.50	74.50	88.32	9.54	12.80	1589.70	0.00	4.52
76/88	39.00	2.00	2.00	3.00	3.00	4.00	3.00	47.50	75.75	80.44	11.40	15.05	1359.36	5.00	3.44
77/90-1	39.50	2.00	3.00	3.00	3.50	3.50	4.00	41.10	61.25	86.38	5.66	9.28	1336.61	10.00	4.52
78/91-1	38.50	0.00	2.00	3.00	3.00	3.50	3.00	36.00	72.00	80.96	9.24	12.85	1450.23	5.00	3.44
79/92-1	38.50	0.00	2.00	3.00	4.00	4.00	4.00	34.00	67.75	79.87	8.68	12.78	1586.68	75.00	14.73
80/93-1	38.00	2.00	0.00	3.00	3.00	4.00	3.50	43.00	66.25	86.99	15.19	22.98	1339.61	70.00	12.09
81/94	39.00	2.00	2.00	3.00	3.50	3.00	3.00	37.00	67.00	93.41	9.05	13.48	1926.03	0.00	4.52
82/95-1	39.00	2.00	2.00	3.50	3.00	3.50	3.00	42.00	62.50	81.26	11.38	18.21	1530.21	0.00	4.52
83/96	38.00	0.00	0.00	3.50	3.00	3.50	3.00	43.00	71.75	90.54	13.41	18.68	2137.29	5.00	3.44
84/97	37.00	0.00	2.00	3.50	3.00	4.00	3.00	43.50	70.50	93.65	9.51	13.49	2056.25	90.00	34.43
85/98-1	37.00	0.00	2.00	3.50	3.00	3.00	3.00	37.50	62.75	89.46	11.91	19.00	2351.58	10.00	4.52
86/101	37.00	0.00	0.00	3.50	3.50	3.50	3.50	41.50	68.50	90.88	7.21	10.58	1880.71	0.00	4.52
87/102	38.50	2.00	2.00	3.50	3.50	4.00	4.00	37.50	62.75	83.80	14.05	22.45	1954.75	5.00	3.44
88/103	38.00	1.00	1.00	3.00	3.50	3.00	3.50	42.00	60.25	84.68	8.39	13.86	1886.29	5.00	3.44
89/105-1	37.00	2.00	2.50	3.50	3.50	3.50	3.50	39.50	67.25	88.25	10.39	15.35	2006.78	95.00	15.37
90/106-1	37.00	2.00	2.00	4.00	3.50	4.50	3.50	38.50	67.00	92.14	8.35	12.46	1966.98	35.00	9.04
91/106-2	36.50	2.50	2.00	4.00	3.50	4.50	4.00	40.00	60.25	79.58	8.87	14.71	1813.54	65.00	14.93
92/107	37.50	2.50	0.00	4.00	3.50	4.50	3.50	46.50	66.50	83.39	9.99	15.10	2082.53	10.00	4.52
93/108	36.50	2.00	2.00	3.50	3.50	4.00	4.00	47.50	68.00	84.87	9.85	14.50	2239.56	0.00	4.52
94/109-1a	36.00	2.00	2.00	3.00	3.50	3.50	3.50	40.00	69.00	78.84	12.76	18.50	1975.42	5.00	3.44
95/110	37.00	1.00	2.00	3.50	3.50	3.50	4.00	43.00	72.75	92.30	12.34	17.00	1914.94	25.00	6.71
96/113	36.50	0.00	0.00	3.50	3.50	3.50	3.50	43.00	71.25	89.98	10.90	15.28	1840.62	25.00	6.71
97/117	37.00	0.00	2.00	3.00	3.00	3.00	3.00	43.43	67.50	94.53	11.72	17.38	2479.58	0.00	4.52
98/120	37.00	2.00	2.00	3.00	3.00	3.00	3.00	46.00	70.75	92.02	13.78	19.49	2227.03	30.00	7.33
99/121	39.50	0.00	0.00	3.00	3.00	3.00	3.00	42.50	56.25	84.07	9.20	16.36	2188.34	0.00	4.52
100/122	37.00	0.00	0.00	3.00	3.00	3.00	3.00	43.00	70.50	82.56	12.41	17.57	2157.70	5.00	3.44

101/123-1	36.50	2.00	2.00	3.00	4.00	3.50	4.50	37.00	60.50	89.64	7.72	12.83	1608.99	0.00	4.52
102/124-1	36.50	2.00	2.00	3.00	3.50	4.50	4.00	36.00	64.75	86.54	8.74	13.55	1722.59	15.00	5.66
103/125-1	36.00	0.00	2.00	3.50	3.50	3.50	4.00	39.00	70.50	89.19	11.10	15.72	1820.97	35.00	8.58
104/126	37.00	0.00	2.00	3.00	3.50	3.50	3.50	43.00	70.50	92.13	13.77	19.56	2185.82	55.00	12.13
105/127	37.50	2.00	2.00	3.00	3.00	3.50	3.50	44.00	67.50	91.20	7.67	11.37	1779.34	0.00	4.52
106/129-2	37.00	1.00	2.00	3.00	3.50	3.50	4.00	41.50	69.25	90.91	7.82	11.32	1734.69	40.00	7.50
107/130-1	36.00	0.00	2.00	3.00	3.50	3.50	4.00	39.00	66.50	85.49	11.24	16.89	1890.94	0.00	4.52
108/131-1	37.00	0.00	2.00	3.00	3.50	3.50	3.50	43.00	66.00	97.16	7.26	11.00	1677.36	20.00	6.30
109/131-2	37.50	2.00	2.00	3.50	3.50	4.00	4.50	37.00	75.25	90.63	10.89	14.38	1605.45	10.00	4.52
110/131-2a	36.50	0.00	2.00	3.00	3.00	3.50	3.50	35.50	69.25	86.54	12.90	18.71	2500.57	80.00	13.00
111/132-3	38.00	2.00	2.00	3.00	3.50	4.50	4.00	42.00	65.00	87.92	8.44	13.02	1940.66	50.00	11.26
112/133-1	37.00	1.00	2.00	3.00	3.50	3.50	4.00	44.50	63.75	86.20	8.42	13.22	2047.00	5.00	3.44
113/134	38.50	2.00	2.00	4.00	4.00	4.50	4.50	40.55	60.66	89.47	10.77	17.75	1656.54	0.00	4.52
114/i1-1	38.50	2.00	2.00	3.50	3.00	4.50	4.00	35.50	67.00	87.53	10.19	15.25	1566.08	35.00	7.25
115/i2-2	37.00	2.00	2.50	3.00	3.00	3.50	3.50	48.00	70.50	89.26	12.20	17.35	1946.63	0.00	4.52
116/i3-1	37.50	2.00	2.00	3.50	3.00	4.50	3.50	40.50	67.75	90.28	8.54	12.64	1595.26	5.00	3.44
117/i3-2	38.00	2.00	2.00	3.50	3.00	3.50	3.50	36.38	67.50	93.84	11.77	17.42	2227.80	0.00	4.52
118/i4-1	38.50	2.00	2.50	3.50	3.50	4.50	3.50	33.67	65.25	95.15	10.13	15.55	2112.97	5.00	3.44
119/i4-2a	39.00	2.00	2.00	3.50	3.00	4.00	3.00	34.50	64.75	91.23	8.28	12.81	2130.38	5.00	3.44
120/i4-3	39.00	0.00	0.00	3.00	3.00	4.00	3.50	36.00	73.25	90.04	7.77	10.61	1721.76	0.00	4.52
121/i5-1	40.00	0.00	0.00	3.00	3.00	4.50	3.50	38.50	75.50	89.03	11.10	14.69	1613.77	10.00	4.52
122/i5-2	37.00	0.00	3.00	3.00	4.00	3.50	4.00	29.22	70.75	81.44	10.33	14.60	1498.77	0.00	4.52
123/i6-1	35.50	2.00	2.00	3.00	3.50	3.50	5.00	38.00	72.25	77.89	12.55	17.35	2114.92	0.00	4.42
124/i7	36.50	0.00	2.00	3.00	3.00	3.00	3.00	35.00	73.25	79.38	8.06	11.00	1799.38	5.00	3.44
125/i7-3	38.50	0.00	1.00	3.00	3.00	3.00	3.50	38.00	70.75	87.36	9.96	14.07	1810.54	0.00	4.52
126/i8-2	40.50	2.00	2.00	3.00	4.00	3.50	4.00	30.71	61.25	62.49	9.69	15.78	1704.76	5.00	3.44
127/i9-1	38.50	2.00	3.00	3.50	4.00	4.50	5.00	35.00	56.25	90.18	7.56	13.45	2146.61	40.00	7.50
128/i9-2a	40.00	2.50	0.00	4.00	4.50	5.50	5.00	33.50	61.75	78.09	6.23	10.08	1943.94	15.00	5.66
129/i9-2b	38.50	2.00	2.50	3.00	4.00	5.50	4.50	38.50	63.75	79.86	9.39	14.77	1960.18	0.00	4.52
130/i16-1	38.50	2.00	2.00	3.00	4.00	4.50	3.50	41.00	74.25	91.09	9.01	12.14	1870.76	45.00	7.75
131/i16-2	38.00	2.00	2.50	3.50	4.50	4.00	5.50	48.07	76.00	88.28	8.13	10.70	1341.48	5.00	3.44
132/i17-2a	38.00	2.00	3.00	3.50	4.50	4.50	5.00	40.00	70.50	79.06	14.11	20.00	2043.81	0.00	4.52
133/i17-2b	38.00	2.00	2.00	3.00	3.50	4.00	4.50	43.00	71.00	90.33	7.37	10.30	1783.53	10.00	4.52
134/i26-1	37.50	0.00	2.00	3.00	3.50	3.50	3.50	42.50	73.75	89.87	9.40	12.75	1905.84	15.00	5.66
135/i29-1	36.50	2.00	2.00	3.50	3.00	4.50	3.00	39.50	71.50	89.85	11.32	15.84	1674.81	45.00	9.34

136/i29-2a	38.50	0.00	0.00	3.00	3.00	3.00	3.00	43.00	69.75	96.63	13.08	18.73	2042.98	5.00	3.44
137/i29-2b	38.50	0.00	0.00	3.00	3.00	3.00	3.00	43.50	75.25	92.50	13.82	18.35	1513.85	0.00	4.52
138/i39-1	39.00	0.00	0.00	3.00	3.50	3.00	4.00	39.00	74.75	90.23	12.68	16.96	2059.16	0.00	4.52
139/i39-2	36.50	2.50	2.00	3.50	3.50	4.50	3.50	41.00	66.00	87.83	10.10	15.34	1943.22	10.00	4.52
140/i39-3	36.00	2.00	0.00	4.00	3.00	5.00	5.50	40.50	73.50	88.95	15.30	20.81	1796.42	20.00	6.30
141/ii1-1	37.50	2.00	0.00	3.00	3.00	3.00	3.00	37.00	66.25	75.64	11.65	17.60	1579.05	0.00	4.52
142/ii1-2	38.00	2.00	2.00	3.50	3.00	4.50	3.50	48.01	45.00	72.48	7.88	17.28	1897.26	0.00	4.52
143/ii2-1	39.00	2.50	2.50	3.50	3.00	4.50	3.50	35.50	56.00	47.50	6.43	11.46	1706.48	0.00	4.52
144/ii7-1a	39.00	2.50	0.00	3.50	4.00	4.50	5.00	38.50	57.50	71.33	8.49	14.77	1381.38	15.00	5.66
145/ii7-1b	38.50	2.00	2.00	3.00	4.00	3.50	4.50	35.50	57.25	91.92	10.95	19.16	1746.15	10.00	4.52
146/ii7-2	37.00	2.00	2.00	3.00	3.50	3.00	3.50	35.00	74.25	92.89	12.42	16.78	1854.48	0.00	4.52
147/ii18-1	38.50	0.00	2.00	3.00	3.50	3.00	3.50	28.31	51.75	78.28	8.90	17.16	1729.59	10.00	4.52
148/ii18-2	36.50	0.00	0.00	3.50	3.00	5.00	3.50	40.00	72.25	89.94	10.48	14.53	1789.70	0.00	4.52
149/ii18-3	37.50	2.50	2.00	3.50	3.50	4.00	3.50	42.39	55.50	74.75	10.57	19.06	1665.09	10.00	4.52
150/ii30-1	37.50	2.00	1.00	3.50	3.50	5.50	3.50	40.00	57.50	67.32	9.93	17.31	2503.48	10.00	4.52
151/ii33-2	37.50	2.00	2.00	3.00	3.00	3.00	4.00	45.00	61.00	83.11	10.33	17.03	1881.65	5.00	3.54
152/ii41-1	37.50	0.00	2.00	3.00	3.00	3.50	4.00	35.50	74.00	80.56	11.16	15.10	2086.01	0.00	4.52
153/1-1	37.50	2.00	2.00	3.00	4.00	4.00	4.00	45.00	54.00	78.70	7.10	13.23	2058.93	0.00	4.52
154/2-2	38.50	2.00	2.00	3.50	3.00	4.00	4.50	41.00	65.00	65.20	10.87	16.77	2028.99	20.00	6.30
155/4	37.00	2.00	2.00	3.50	3.00	4.00	4.50	41.50	65.25	82.93	8.95	13.74	1995.63	15.00	5.66
156/5-1	37.00	2.00	2.00	3.50	3.50	4.50	4.50	39.50	68.00	84.04	12.50	18.29	2469.37	15.00	5.66
157/6b-2	38.00	0.00	2.00	3.00	4.00	4.00	5.00	41.00	61.25	84.91	13.30	21.77	2550.56	0.00	4.52
158/7-1	37.00	2.00	2.00	3.00	4.00	4.50	4.00	44.00	70.75	85.55	9.54	13.50	2158.47	30.00	7.00
159/9-1	36.50	2.00	2.00	3.00	4.50	3.50	5.00	44.64	57.61	84.41	9.16	15.98	2248.08	5.00	3.44
160/11-1	37.50	2.50	2.00	3.00	4.50	4.50	5.00	41.50	72.00	89.47	10.43	14.48	2023.39	75.00	13.24
161/12-1	37.00	2.00	2.00	4.00	4.50	5.50	4.50	36.50	65.25	91.83	9.51	14.57	2246.56	20.00	6.30
162/13-1	36.50	2.50	2.00	4.00	4.00	4.50	4.00	42.00	64.75	67.39	11.76	18.15	2568.66	5.00	3.44
163/14-1	37.00	1.00	2.00	3.50	3.50	5.00	4.00	42.50	69.00	91.36	12.38	18.00	2238.84	0.00	4.52
164/15-2	37.50	2.00	2.00	3.50	3.50	4.00	3.50	43.00	60.00	93.71	8.37	14.00	2026.79	0.00	4.52
165/16	37.00	1.00	1.00	3.50	3.50	5.50	3.50	38.50	70.00	97.57	8.40	12.00	2373.13	100.00	18.12
166/17-1	37.50	2.00	2.00	4.00	4.50	4.00	5.00	40.00	67.75	80.77	13.67	20.18	1687.59	15.00	5.66
167/19	37.50	2.00	2.00	4.00	4.50	6.00	5.00	33.50	60.75	88.62	7.89	12.93	1448.18	20.00	6.30
168/21-1	36.50	2.00	2.00	4.00	4.00	4.50	4.50	47.99	55.00	87.14	10.26	18.67	1869.78	5.00	3.44
169/24-1a	37.50	2.50	2.50	4.00	4.50	4.00	4.50	43.00	54.00	79.88	8.84	16.46	2564.44	0.00	4.52
170/26-2	36.50	2.00	3.00	3.50	3.50	4.50	5.00	42.00	57.00	79.91	9.70	16.99	1998.49	25.00	6.71

171/27-3	36.00	2.00	3.00	3.50	3.50	6.00	4.50	43.00	70.00	77.88	9.96	14.24	1944.11	10.00	4.52
172/28-1	38.00	2.00	2.00	4.00	3.00	6.00	4.00	38.00	72.75	89.42	11.41	15.73	1463.51	60.00	19.54
173/30-1	38.00	0.00	2.00	3.50	4.50	3.50	5.50	37.00	61.00	81.31	10.23	16.76	2449.34	0.00	4.52
174/32-1	36.50	2.00	2.00	3.00	3.00	4.00	4.50	29.57	55.75	70.91	11.72	20.96	2282.84	10.00	4.52
175/33-1	36.50	2.00	2.00	3.00	3.00	5.00	4.50	41.00	66.50	89.16	11.76	17.61	2126.18	15.00	5.66
176/33-3a	37.00	2.00	2.00	3.50	3.50	5.00	4.00	47.50	63.00	72.50	12.61	20.00	1982.55	30.00	7.00
177/33-3b	37.00	2.00	0.00	3.50	3.50	3.50	3.50	37.30	60.00	74.04	9.63	16.06	2779.43	5.00	3.44
178/51	37.50	2.00	2.00	3.50	3.50	3.50	3.50	42.00	58.50	72.94	10.83	18.50	2346.31	0.00	4.52
179/37-2	40.00	0.00	0.00	3.00	3.00	4.00	3.50	41.69	53.00	74.75	10.31	19.57	1696.13	0.00	4.52
180/38	38.50	2.50	2.50	3.50	3.50	4.00	4.00	49.62	70.00	67.57	11.08	15.86	2102.67	0.00	4.52
181/39-3	38.00	1.00	3.00	3.00	3.00	4.00	3.00	32.50	61.25	86.61	12.67	20.75	2186.27	10.00	4.52
182/40	38.00	2.00	2.00	3.50	3.50	3.50	3.50	47.50	61.00	94.12	10.85	17.73	2052.32	0.00	4.52
183/41-1	38.50	2.50	3.50	3.00	3.50	4.50	4.00	33.50	48.75	85.41	10.95	22.50	2275.41	65.00	22.00
184/42-1	38.50	2.50	2.00	3.50	3.00	4.50	3.00	40.44	63.96	81.92	11.71	18.19	2151.81	0.00	4.52
185/43-2	38.00	2.00	2.00	3.50	3.50	3.50	4.50	34.00	63.00	81.23	9.13	14.39	1909.34	10.00	4.52
186/45-2	39.00	2.00	2.00	3.00	3.00	4.00	3.50	30.50	62.00	59.99	9.55	15.37	1812.69	0.00	4.52
187/46-1	39.00	1.00	2.00	3.00	3.00	3.50	3.00	38.00	66.50	80.83	10.52	15.87	2269.01	10.00	4.52
188/48	39.00	2.00	2.50	3.50	3.50	4.00	4.50	39.00	61.25	72.06	11.78	19.25	2054.61	20.00	6.30
189/49	39.00	0.00	3.00	3.50	4.00	3.50	5.00	38.50	60.50	89.46	11.01	18.18	1643.37	10.00	4.52
190/50-2	38.50	0.00	3.00	3.50	4.00	3.50	4.50	36.50	57.75	81.20	8.92	15.45	2066.70	0.00	4.52
191/51-1	39.00	0.00	2.00	4.00	3.50	4.00	3.50	41.50	60.00	67.33	13.90	23.36	1945.98	15.00	5.66
192/52-3	39.50	2.00	2.50	3.50	4.00	3.50	4.50	45.00	68.00	95.34	10.16	14.90	2290.19	0.00	4.52
193/53-2	39.50	2.00	2.50	3.00	3.50	3.50	3.50	44.00	74.25	81.24	14.01	18.87	2399.23	10.00	4.52
194/54-1	39.00	2.00	3.00	3.00	3.50	4.00	4.00	46.50	69.75	84.84	11.69	16.81	2061.28	10.00	4.52
195/56-2	39.50	2.50	2.00	3.50	3.00	3.50	4.00	40.00	56.25	83.87	7.08	12.68	1923.15	85.00	11.71
196/57-1	39.50	2.00	2.50	3.50	3.50	3.50	4.00	37.50	68.75	89.44	7.27	10.53	2627.54	40.00	7.50
197/58-1	39.00	2.00	2.00	3.50	3.50	3.00	3.50	45.50	68.75	81.91	13.81	20.10	2173.48	0.00	4.52
198/59-1	38.00	2.00	2.00	3.00	3.50	3.00	3.50	36.00	73.25	88.79	11.71	16.00	2127.67	25.00	6.71
199/59-3	38.50	2.00	2.00	3.00	4.00	3.00	3.50	31.55	60.00	91.30	9.67	16.22	2078.14	10.00	4.52
200/60-1	39.50	2.00	2.00	3.00	3.00	3.00	3.50	35.50	66.00	91.35	14.03	21.23	1846.34	5.00	3.44
201/60-2	38.50	2.00	2.00	3.00	3.50	3.50	4.00	33.50	71.25	90.55	11.71	16.39	2282.14	5.00	3.44
202/60	39.00	2.00	3.00	3.00	4.00	4.00	4.50	41.00	63.00	91.85	9.32	14.76	1891.06	75.00	12.33
203/60-3	38.00	2.00	0.00	3.00	3.50	4.00	3.50	42.50	69.00	98.80	11.43	16.60	1656.67	10.00	4.52
204/62-2	38.00	1.00	0.00	3.00	3.00	4.50	3.00	40.00	61.00	91.51	10.67	17.50	1901.37	10.00	4.52
205/64-1	37.00	1.00	0.00	3.50	3.00	4.00	3.00	39.00	63.50	90.33	7.13	11.21	1601.26	0.00	4.52

206/65-1	37.00	1.00	0.00	3.00	3.00	4.50	3.00	39.00	59.00	86.36	8.86	14.96	1684.97	0.00	4.52
207/67-1	38.50	2.00	2.00	3.00	3.50	4.00	4.00	51.00	75.25	88.40	9.31	12.37	2156.37	5.00	3.44
208/63	36.00	2.00	2.00	3.50	3.00	4.50	3.50	45.00	60.25	89.16	7.04	11.57	1826.03	0.00	4.52
209/64-3	36.50	2.00	2.00	3.50	3.00	4.00	3.00	36.00	58.00	87.13	7.58	13.04	2293.54	90.00	31.81
210/65	37.00	2.00	2.00	3.00	3.00	3.50	3.00	44.00	70.25	86.75	10.09	14.32	2005.06	0.00	4.52
211/66	36.50	0.00	2.00	3.00	3.00	3.00	3.00	44.00	68.50	90.17	9.01	13.05	2448.67	5.00	4.52
212/68-1	36.50	0.00	2.00	3.50	3.00	4.00	4.50	39.50	71.75	86.29	13.76	19.14	1743.90	0.00	4.52
213/69-2	37.00	2.00	2.50	4.00	4.00	4.00	4.00	37.00	59.25	87.20	8.26	14.01	2103.11	70.00	28.57
214/70-2	37.50	2.00	3.00	3.50	4.00	4.50	4.50	38.00	66.50	75.70	10.96	16.33	1916.53	40.00	7.49
215/71-1	37.50	2.00	2.50	3.50	4.00	4.00	5.00	34.00	58.75	93.21	9.28	15.81	1998.61	0.00	4.52
216/72-2	37.00	2.00	2.50	3.50	4.50	4.50	4.50	41.00	59.50	83.00	5.62	9.40	2117.39	30.00	7.00
217/73-1	36.50	2.00	2.00	3.00	3.50	4.50	6.00	39.00	53.25	85.38	7.11	13.35	2277.63	75.00	8.96
218/74-1	37.50	2.00	2.00	3.00	3.00	4.00	3.50	49.00	63.50	89.05	13.62	21.34	2329.81	5.00	3.44
219/75-1	38.00	2.00	2.00	3.00	3.00	3.50	3.50	42.50	70.50	91.20	13.05	18.50	2057.90	5.00	3.44
220/76-1	36.50	2.00	2.00	3.50	3.00	4.50	3.00	41.00	60.00	86.30	10.93	18.22	1898.82	50.00	10.29
221/77-1	36.50	2.00	2.50	3.00	3.00	4.00	4.00	43.50	70.00	84.85	14.00	20.00	1844.80	0.00	4.52
222/78-1	36.00	2.00	3.00	3.00	3.00	4.00	4.00	57.00	37.50	68.09	6.02	15.39	1965.49	55.00	10.29
223/79-1	37.00	2.00	2.00	3.00	3.00	3.50	4.00	36.50	71.50	82.28	13.26	18.50	2160.40	0.00	4.52
224/80-1	36.50	2.00	2.00	3.00	3.50	3.50	4.00	44.00	62.50	60.09	12.50	20.00	2421.82	0.00	4.52
225/82b-2	37.50	2.00	2.00	3.00	3.00	4.50	5.00	36.50	58.00	75.31	11.02	19.00	2051.76	5.00	3.44
226/84-1	37.00	2.00	2.00	3.00	3.50	4.00	4.00	41.50	62.75	84.27	12.80	20.40	2346.36	10.00	4.52
227/86	37.50	2.00	3.00	3.00	3.50	3.50	5.00	31.14	49.75	62.70	9.91	19.78	2625.73	0.00	4.52
228/87	37.50	0.00	2.00	3.00	3.50	3.50	4.50	41.00	69.25	78.39	13.47	19.49	2507.72	0.00	4.52
229/88	37.50	2.50	2.00	3.00	4.00	4.50	4.00	37.50	68.25	84.67	7.33	10.75	1925.48	0.00	4.52
230/89-1	37.00	2.00	2.00	3.00	3.00	3.00	3.00	39.50	63.00	86.95	11.55	18.41	2503.15	30.00	7.00
231/90	37.00	0.00	2.00	3.00	3.00	3.00	3.00	39.50	68.75	85.96	13.26	19.32	2046.71	0.00	4.52
232/92-1	37.00	0.00	2.00	3.00	3.00	3.00	3.00	41.50	70.75	82.33	15.12	21.33	2492.95	5.00	3.44
233/91-2	36.00	2.00	2.00	3.00	3.00	3.50	3.00	39.00	69.75	82.54	11.90	17.08	2698.51	0.00	4.52
234/95-1	36.00	2.00	2.00	3.00	3.00	3.00	3.00	33.50	66.00	85.60	13.63	20.66	2294.81	5.00	3.44
235/97-1	37.00	2.00	2.50	3.00	3.50	3.00	3.00	43.54	51.75	84.60	10.36	20.00	2535.26	15.00	5.66
236/96-2	37.50	2.00	2.50	3.00	3.50	3.50	4.00	37.50	68.50	66.63	13.49	19.68	2813.53	5.00	3.44
237/98-1	38.00	2.00	3.00	3.50	4.00	3.50	4.50	41.50	69.25	67.10	11.74	16.95	2976.22	20.00	6.30
238/99-1	36.50	2.00	2.00	3.00	3.50	3.50	4.50	45.50	70.50	87.20	13.53	19.20	2547.73	0.00	4.52
239/100	38.50	2.00	2.50	3.00	3.00	3.50	3.50	40.50	72.50	97.16	14.26	19.66	2208.01	0.00	4.52
240/101-1	39.00	2.00	2.00	3.50	3.00	4.50	3.00	37.50	76.75	96.75	15.66	20.38	1862.45	0.00	4.52

241/103-1	39.00	0.00	2.50	3.50	3.00	4.00	3.00	40.00	72.50	90.63	9.82	13.55	2463.52	0.00	4.52
242/91-1	37.50	2.00	2.00	3.50	3.00	4.00	3.00	36.50	77.00	90.46	9.94	12.93	2314.14	40.00	7.50
243/94-2	37.50	2.00	2.00	3.00	3.00	3.00	3.00	38.00	67.75	91.38	13.65	20.14	2501.00	10.00	4.52
244/96-3	39.50	2.00	2.00	3.00	3.00	3.50	4.00	37.50	66.75	89.37	10.53	15.76	2549.16	5.00	3.44
245/ii2-1	40.00	2.00	2.50	3.00	4.00	4.00	4.50	41.50	70.50	95.11	13.32	18.87	2504.97	40.00	7.50
246/3-2	40.00	2.00	2.00	3.50	4.00	4.50	4.00	35.00	75.50	95.57	11.88	15.73	2143.77	5.00	3.44
247/6b-3	39.50	0.00	2.50	3.50	4.00	4.50	4.00	36.00	69.00	94.74	13.34	19.33	2108.44	65.00	13.19
248/8-1	38.00	2.00	2.50	3.50	4.00	4.50	4.50	42.00	74.75	85.18	14.01	18.71	2645.24	70.00	12.57
249/18b	38.00	0.00	2.50	3.50	3.50	4.00	5.00	42.50	75.50	88.15	11.19	14.86	1967.33	0.00	4.52
250/23-1	38.00	0.00	2.50	3.50	3.00	4.50	3.00	52.00	74.25	95.31	9.30	12.53	2191.78	15.00	5.66
251/29	38.00	2.00	2.00	3.50	3.00	4.00	3.00	45.00	72.25	92.44	7.75	10.73	1619.69	10.00	4.52
252/32-2	37.50	2.00	2.00	3.50	3.00	4.50	4.00	41.50	78.25	95.79	9.11	11.63	2065.27	15.00	5.66
253/35-2	37.50	2.00	2.50	3.50	3.00	4.00	5.00	46.00	75.25	91.52	12.53	16.65	2309.87	0.00	4.52
254/39-2	38.00	2.00	2.50	3.00	3.00	3.00	3.50	43.00	69.25	95.29	11.53	16.68	1887.88	70.00	12.09
255/40	37.50	2.00	2.50	3.00	3.00	3.00	3.00	40.50	73.00	97.41	8.21	11.23	1783.36	60.00	11.53
256/44	37.50	2.00	2.00	3.00	3.00	3.00	3.00	41.50	76.00	92.30	14.77	19.42	2669.53	10.00	3.44
257/45-3a	37.50	2.00	2.00	3.50	3.00	3.50	3.00	42.00	65.25	91.60	11.31	17.33	1966.56	35.00	8.15
258/57-2	38.00	2.00	2.00	3.00	3.00	4.50	3.00	42.50	76.25	89.33	13.14	17.24	1773.41	0.00	4.52
259/61-1	39.50	1.00	2.00	3.50	3.00	4.00	3.00	38.50	62.25	82.24	8.66	13.95	2334.99	70.00	33.57
260/66	38.50	2.00	2.00	3.50	3.00	4.50	4.00	36.00	65.50	94.44	12.56	19.10	2106.47	10.00	4.52
261/81-1	39.50	0.00	2.00	3.00	3.00	3.00	4.50	22.00	45.00	42.01	5.65	12.56	2077.44	0.00	4.52
262/83-3	37.50	2.00	2.50	3.50	3.50	3.50	5.00	38.50	66.75	91.83	10.94	16.39	2598.70	0.00	4.52
263/85	37.00	0.00	3.00	3.50	3.50	4.50	5.50	37.00	67.50	92.06	6.00	8.90	2118.13	10.00	4.52
264/102-1	37.50	2.00	2.50	3.00	4.00	4.50	4.50	38.50	64.75	84.75	12.39	19.07	1417.80	0.00	4.52
265/81-1	36.50	2.00	2.50	3.50	3.50	4.50	4.50	37.50	71.75	94.75	8.32	11.53	1576.51	80.00	13.44
266/83-3	37.00	2.00	2.50	3.50	4.00	5.00	5.00	35.50	64.00	81.65	7.47	11.67	1862.82	40.00	8.81
267/85	37.50	1.00	2.00	3.50	4.00	4.50	3.00	36.50	50.50	76.74	9.71	19.23	1899.02	50.00	17.22
268/102-1	36.50	2.00	3.00	3.00	3.50	4.00	3.50	38.00	67.00	81.64	8.12	12.19	7980.72	5.00	4.52
TAG-24	39.00	2.00	3.00	3.50	4.00	4.00	4.50	48.00	72.00	85.35	6.99	9.71	1830.58	10.00	4.52
GPBD-4	38.50	0.00	0.00	0.00	0.00	2.00	2.00	42.50	75.00	88.36	9.02	12.05	2565.35	50.00	10.29
SEm	1.17	0.32	0.24	0.30	0.39	0.54	0.59	4.30	3.33	7.70	0.92	1.23	54.52	0.47	0.16
CD@1%	4.29	1.16	0.90	1.12	1.43	1.96	2.19	15.66	12.15	28.08	3.37	4.48	185.31	1.73	0.59
CD@5%	3.26	0.88	0.68	0.85	1.09	1.49	1.65	11.92	9.24	21.37	2.50	3.41	151.35	1.31	0.45

Appendix III: Character mean of RIL population during *Kharif*

	DFF	Rust@ 70	LLS@ 70	Rust@ 80	LLS@ 80	Rust@ 90	LLS@ 90	HKW (g)	SP (%)	SMK (%)	KY (g/plant)	DPY (g/plant)	DPY (kg/ha)	Oil	Protein	Intensity of dormancy	Duration of dormancy
1/1-1	30.50	3.00	3.50	4.00	6.00	4.50	7.50	36.00	61.00	90.78	6.69	10.99	1468.74	44.29	27.78	0.00	4.52
2/2-1	30.00	3.00	3.00	4.50	3.50	6.00	4.50	46.00	57.00	80.16	7.63	13.31	1326.05	47.72	29.36	0.00	4.52
3/3-1	30.00	3.00	3.00	3.50	4.00	4.50	4.50	48.00	70.00	100.00	14.52	20.77	1794.63	45.60	24.69	0.00	4.52
4/4-1	30.00	3.00	3.00	4.00	5.00	5.50	5.00	47.00	77.00	95.92	17.09	22.17	1780.97	48.86	28.53	0.00	4.52
5/5	31.00	3.00	3.00	4.00	5.00	6.00	5.50	42.00	67.00	89.32	10.63	15.68	1797.69	48.85	27.15	70.00	36.87
6/6	31.00	3.00	3.00	4.00	4.50	4.00	6.00	40.00	62.00	100.00	10.30	16.62	1588.16	45.88	29.70	10.00	4.52
7/7-1	30.50	3.00	3.00	4.00	4.00	4.00	4.50	33.00	69.00	96.23	9.82	14.26	1824.87	44.64	27.23	0.00	4.52
8/8-2	29.50	3.00	3.00	4.00	5.00	4.00	7.00	39.00	70.00	87.26	11.28	16.12	1732.06	45.50	29.79	0.00	4.52
9/9	30.00	4.00	3.00	5.00	4.00	6.50	4.50	43.00	66.00	100.00	11.22	17.03	1675.46	46.01	27.92	0.00	4.52
10/10-1	30.50	3.00	3.00	4.00	5.50	4.00	7.00	40.00	71.00	94.95	12.89	18.15	1865.23	45.58	26.63	0.00	4.52
11/11-1	30.50	3.00	4.00	4.00	5.50	4.50	7.00	44.00	61.00	93.92	8.16	13.30	1674.30	46.93	28.15	10.00	4.52
12/13-1	30.50	3.00	3.00	4.00	5.00	4.50	7.00	54.00	82.00	100.00	15.20	18.55	1952.26	45.88	26.28	0.00	4.52
13/14-1a	30.50	3.00	3.00	4.00	4.00	4.00	4.50	45.00	72.00	93.21	18.55	25.82	2684.29	48.52	25.89	0.00	4.52
14/14-2	30.00	3.00	3.00	5.50	4.00	7.00	4.00	53.00	77.00	100.00	14.81	19.28	1969.61	49.57	28.54	0.00	4.52
15/15	30.00	3.00	3.00	4.00	4.50	4.00	5.50	46.00	67.00	100.00	13.32	19.85	1993.40	45.30	28.80	0.00	4.52
16/16	30.00	3.00	3.50	5.50	5.00	6.50	7.50	36.00	69.00	100.00	9.28	13.49	1513.26	42.90	25.19	0.00	4.52
17/17-a	30.00	3.00	3.50	4.00	5.00	5.00	7.50	44.00	70.00	92.55	13.71	19.56	2040.74	46.79	26.43	0.00	4.52
18/18	30.50	3.00	3.50	4.00	5.50	5.00	7.50	47.00	76.00	95.45	16.20	21.31	2181.89	46.62	29.04	0.00	4.52
19/19	31.00	3.50	3.50	5.50	4.50	7.50	7.50	67.75	66.50	92.70	9.51	14.27	1659.04	42.87	29.04	0.00	4.52
20/20-1	30.50	3.00	3.50	5.00	5.50	7.00	7.50	50.00	76.00	100.00	11.80	15.55	2000.55	49.83	26.05	5.00	3.44
21/21	30.50	3.00	3.50	4.00	5.00	5.50	7.50	49.00	78.00	100.00	13.80	17.64	1762.54	44.60	27.55	0.00	4.52
22/22A	30.00	3.00	3.00	4.00	4.00	4.00	5.50	44.00	72.00	97.22	15.00	20.84	2088.45	47.44	27.78	0.00	3.54
23/23-2	30.00	3.00	3.00	5.50	4.00	5.50	5.00	41.00	69.00	96.51	11.21	16.25	1723.55	44.06	28.55	0.00	4.52

24/24-1	30.00	3.00	3.50	4.50	5.50	5.50	6.50	42.00	76.00	96.12	16.63	21.89	2077.93	45.85	28.36	0.00	4.52
25/25	30.50	3.00	3.00	3.50	3.50	4.00	5.50	43.00	78.00	100.00	12.98	16.67	1758.39	46.78	29.04	15.00	5.66
26/26-1	30.50	3.00	3.50	4.00	5.50	4.50	7.50	37.00	74.00	100.00	10.24	13.78	2022.51	44.45	27.45	10.00	4.52
27/26-2	30.50	3.00	3.00	4.50	4.00	4.00	6.50	43.00	76.00	100.00	12.60	16.55	1712.13	48.00	28.73	20.00	6.30
28/26-2b	30.00	3.00	3.00	4.50	3.50	7.00	4.50	42.00	74.00	96.51	13.30	17.93	1969.48	49.27	30.56	0.00	4.52
29/27-1a	30.50	3.00	3.00	4.00	4.00	5.00	6.00	55.00	76.00	96.25	17.76	23.35	2320.87	47.40	30.82	0.00	4.52
30/27-2	30.50	3.00	3.50	4.00	6.00	4.50	7.50	49.00	69.00	88.60	13.40	19.45	2066.35	51.22	34.93	70.00	36.87
31/28-2	30.50	3.50	3.00	5.00	4.00	7.00	4.50	42.00	76.00	100.00	17.12	22.52	1968.80	47.46	26.38	10.00	4.52
32/30-1	30.00	3.50	3.00	6.00	4.50	6.50	5.50	43.00	66.00	93.12	13.94	21.08	2166.63	49.62	28.98	0.00	4.52
33/34-1	30.00	3.50	3.00	5.50	4.50	8.00	6.00	60.00	83.00	100.00	17.23	20.72	2028.02	44.65	36.95	5.00	3.44
34/35	31.00	3.00	3.00	4.50	4.00	7.00	6.00	46.00	66.00	96.51	8.94	13.50	1560.23	46.80	28.11	0.00	4.52
35/36	30.00	4.00	3.00	5.00	4.00	7.50	6.00	43.00	74.00	100.00	10.89	14.75	1643.53	44.19	28.57	10.00	4.52
36/38	30.00	3.00	3.00	4.50	4.50	5.50	6.50	46.00	80.00	96.55	15.38	19.22	2149.80	46.33	27.84	10.00	4.52
37/39-2	30.00	4.00	3.00	5.00	4.00	7.00	7.50	41.00	66.00	95.00	12.64	19.10	2146.97	45.51	25.39	0.00	4.52
38/41-2	30.00	3.50	3.50	5.50	5.00	6.50	6.00	51.00	67.00	89.64	11.02	16.38	1964.21	46.11	28.03	0.00	4.52
39/42	30.50	3.00	3.00	4.00	4.00	5.50	5.50	45.00	76.00	91.88	10.85	14.25	1492.05	46.98	29.63	0.00	4.52
40/43-1	30.00	3.50	3.50	5.50	5.00	6.50	7.50	49.00	75.00	100.00	12.82	17.10	1619.54	49.17	27.42	75.00	15.22
41/44	30.50	3.00	3.00	5.00	4.00	6.50	5.50	52.00	76.00	92.68	10.49	13.85	1548.63	44.85	30.07	10.00	4.52
42/45-3	30.50	3.00	3.00	4.00	4.50	4.50	5.50	43.00	74.00	100.00	11.31	15.26	1749.13	47.29	26.98	5.00	3.44
43/46-1	30.00	3.00	3.00	4.00	4.50	4.50	5.00	49.00	72.00	93.67	13.65	18.90	1917.48	46.72	27.34	0.00	4.52
44/47-1	30.00	3.00	3.00	4.00	4.50	4.50	5.50	45.00	72.00	100.00	16.02	22.26	2411.88	49.64	27.78	5.00	3.44
45/48	30.00	3.00	3.00	4.00	4.50	4.50	6.50	51.00	81.00	100.00	14.17	17.40	1927.66	47.77	26.20	10.00	4.52
46/49	30.00	4.00	3.50	4.00	5.50	4.50	7.50	37.00	67.00	94.23	12.09	18.05	1888.79	46.22	28.08	0.00	4.52
47/50-2	30.00	3.00	3.50	4.00	6.50	4.50	8.00	47.00	76.00	100.00	12.59	16.57	2175.84	46.04	27.70	5.00	3.44
48/51	30.00	4.00	3.00	4.50	5.50	7.00	4.00	51.00	84.00	100.00	12.86	15.35	1804.69	48.95	25.49	65.00	8.48
49/52-2	30.00	3.00	3.50	4.00	6.00	4.50	8.00	49.00	74.00	85.19	12.97	17.50	1716.52	45.23	27.23	0.00	4.52
50/53	30.50	3.00	3.50	4.00	5.50	4.50	8.50	40.00	66.00	90.35	9.29	14.07	1376.72	47.43	25.87	0.00	4.52

51/55	30.00	3.00	3.00	4.50	4.00	7.00	4.00	51.00	70.00	100.00	12.67	18.18	2085.11	48.34	26.61	15.00	5.66
52/56-2	30.00	3.00	3.00	4.50	4.00	6.50	4.00	47.00	78.00	96.30	12.03	15.45	1747.21	47.45	24.84	10.00	4.52
53/57	30.00	3.00	3.00	4.50	4.00	6.00	4.00	52.00	76.00	100.00	13.87	18.25	1943.69	43.65	27.43	20.00	6.30
54/60-1b	30.00	3.00	3.00	4.50	4.00	6.50	4.00	45.00	69.00	100.00	12.81	18.16	1916.50	50.48	26.06	0.00	4.52
55/62	30.00	3.00	3.00	4.00	4.00	4.50	5.00	51.00	84.00	100.00	16.10	19.15	2042.80	46.37	29.45	0.00	4.52
56/63	30.00	3.00	3.00	4.50	4.00	6.50	4.50	55.00	76.00	95.40	15.74	20.62	1836.82	45.98	28.32	0.00	4.52
57/64-1	30.50	3.00	3.00	4.50	4.00	6.00	5.50	47.00	79.00	100.00	14.19	17.96	2226.23	47.34	30.21	10.00	4.52
58/65	30.50	3.00	3.00	4.00	4.00	4.50	5.50	54.00	76.00	91.49	17.18	22.60	2033.09	43.32	25.16	0.00	4.52
59/68	30.00	3.00	3.00	4.00	4.50	5.00	6.50	54.00	77.00	100.00	18.68	24.30	2498.37	45.53	29.22	0.00	4.52
60/69	30.50	3.00	3.00	4.00	4.00	5.00	5.00	53.00	72.00	89.70	12.92	17.81	1644.25	47.56	28.18	0.00	4.52
61/70-2	30.00	3.00	3.00	4.50	5.50	4.50	8.00	55.00	77.00	96.88	11.83	15.38	1866.70	47.17	27.46	0.00	4.52
62/71-1	30.50	3.00	3.00	4.00	4.00	4.00	5.00	47.00	76.00	100.00	11.70	15.52	1745.11	44.41	29.44	0.00	4.52
63/72-1	30.00	3.00	4.00	4.00	5.50	4.00	9.00	48.00	75.00	95.45	13.04	17.40	2039.79	46.92	28.40	0.00	4.52
64/73-1	30.00	3.00	4.00	4.00	6.00	4.00	9.00	43.00	74.00	95.00	10.57	14.53	1551.26	46.49	30.86	0.00	4.52
65/76-1	30.50	3.50	3.50	4.00	4.00	7.50	4.00	54.00	68.00	100.00	8.88	13.10	1957.96	46.41	27.96	0.00	4.52
66/77-1	30.50	3.00	3.00	4.00	4.00	4.50	7.00	50.00	78.00	95.45	13.74	17.69	1872.23	48.89	27.83	0.00	4.42
67/78-2	30.50	3.50	3.00	4.50	5.00	6.00	7.00	48.00	75.00	94.62	16.36	22.12	1990.37	47.71	30.45	0.00	4.52
68/79	30.50	3.00	3.00	4.00	4.00	5.00	6.50	54.00	74.00	100.00	15.47	20.90	2347.68	47.95	28.49	0.00	4.52
69/80-1	30.00	3.00	3.00	4.00	4.00	4.50	6.50	56.00	79.00	96.67	17.96	22.70	2371.32	48.39	32.08	0.00	4.52
70/81	30.50	3.00	3.00	5.00	4.00	7.00	5.50	56.00	64.00	93.10	15.21	23.65	2194.76	48.00	31.66	0.00	4.52
71/82a	30.50	3.00	3.00	4.00	5.50	5.00	8.00	46.00	75.00	100.00	13.31	17.67	1955.75	47.59	28.94	0.00	4.52
72/83-1	31.00	3.00	3.00	4.00	4.00	4.00	4.00	45.00	75.00	88.13	13.77	18.45	2051.27	49.72	29.12	55.00	10.16
73/84-1	30.00	3.00	3.50	4.00	5.50	4.00	7.50	35.00	73.00	97.62	9.22	12.66	1500.08	47.05	28.52	0.00	3.44
74/85-1	30.00	3.00	3.00	4.00	4.00	4.00	4.00	38.00	64.00	100.00	10.93	17.00	1744.98	47.84	27.57	0.00	4.52
75/87	30.00	3.00	3.00	4.00	5.50	4.00	7.50	42.00	78.00	97.01	13.27	17.05	1806.70	44.54	28.35	0.00	4.52
76/88	30.50	3.50	3.00	5.00	4.00	7.50	4.50	45.00	68.00	88.89	12.77	18.75	1576.36	48.08	29.35	65.00	10.13
77/90-1	30.00	3.00	3.50	4.00	5.50	4.00	8.50	40.00	81.00	100.00	9.57	11.80	1553.61	48.16	33.38	0.00	4.52

78/91-1	30.00	3.00	3.00	5.00	4.00	7.00	4.00	41.00	64.00	100.00	10.41	16.25	1667.23	48.68	26.28	0.00	4.52
79/92-1	30.50	3.50	3.00	4.50	5.50	4.50	7.50	44.00	67.00	74.78	10.53	15.78	1803.68	47.93	30.67	50.00	14.96
80/93-1	30.50	3.00	3.00	4.00	4.50	5.00	4.50	49.00	68.00	94.25	9.25	13.55	1556.61	46.50	26.87	0.00	4.52
81/94	30.50	3.00	3.00	4.00	4.50	4.50	7.50	42.00	72.00	100.00	13.79	19.15	2143.03	47.70	27.42	0.00	4.52
82/95-1	30.00	3.00	3.00	4.00	4.50	5.50	5.00	48.00	77.00	100.00	13.73	17.90	1747.21	47.10	28.58	0.00	4.52
83/96	30.00	3.00	3.00	4.00	4.00	4.50	5.50	51.00	74.00	100.00	15.45	20.94	2354.29	47.96	30.26	0.00	4.52
84/97	30.50	3.50	3.00	4.00	5.00	6.00	7.00	43.00	78.00	93.48	16.72	21.36	2273.25	47.38	29.86	55.00	22.35
85/98-1	30.00	3.00	3.00	4.00	4.00	4.00	4.50	44.00	70.00	100.00	16.17	23.10	2568.58	49.96	30.40	0.00	4.52
86/101	30.50	3.00	3.00	4.00	5.50	6.00	7.00	39.00	61.00	100.00	12.16	20.05	2097.71	49.52	28.59	0.00	4.52
87/102	30.00	3.00	3.50	4.00	5.00	5.50	7.00	43.00	72.00	87.94	15.55	21.60	2171.75	49.52	29.94	0.00	4.52
88/103	30.00	3.00	3.00	4.00	4.00	5.00	5.50	44.00	66.00	93.75	13.96	21.15	2103.29	49.41	25.49	0.00	4.52
89/105-1	30.00	3.00	3.50	5.00	5.00	8.00	5.50	42.00	69.00	82.23	15.53	22.55	2223.78	47.63	28.26	65.00	8.48
90/106-1	30.00	3.50	3.50	5.50	4.00	8.00	5.00	46.00	80.00	100.00	16.47	20.55	2183.98	46.92	28.50	50.00	11.74
91/106-2	30.50	3.50	3.00	5.50	4.00	8.00	5.00	46.00	79.00	94.25	16.22	20.55	2030.54	45.53	22.80	0.00	4.52
92/107	30.50	3.50	3.50	5.50	4.00	7.50	5.00	43.00	67.00	100.00	15.26	22.55	2299.53	46.80	28.34	0.00	4.52
93/108	30.00	3.00	3.50	5.00	6.00	7.00	7.50	42.00	69.00	100.00	15.93	23.40	2456.56	49.67	30.60	15.00	5.66
94/109-1a	30.50	3.00	3.50	4.00	4.50	4.50	6.00	43.00	71.00	95.87	15.58	21.95	2192.42	46.77	29.84	0.00	4.52
95/110	31.00	3.00	3.50	4.00	6.00	4.50	8.00	45.00	68.00	94.62	14.05	20.75	2131.94	46.81	28.28	45.00	13.90
96/113	30.00	4.00	3.00	5.50	3.50	6.00	4.00	40.00	68.50	89.39	13.21	19.30	2057.62	48.22	28.56	10.00	4.52
97/117	30.50	3.00	3.00	4.00	4.00	4.00	5.50	53.00	79.00	100.00	20.80	26.25	2696.58	47.02	28.27	0.00	4.52
98/120	30.50	3.00	3.00	4.00	4.00	4.00	5.50	47.00	76.00	95.18	17.82	23.45	2444.03	48.77	27.47	0.00	4.52
99/121	30.00	3.00	3.00	4.00	5.00	4.50	8.00	48.00	76.00	100.00	18.33	23.98	2405.34	47.15	29.30	0.00	4.52
100/122	30.00	3.00	3.00	4.00	5.50	4.50	7.00	43.00	68.00	100.00	15.24	22.70	2374.70	47.51	28.95	0.00	4.52
101/123-1	30.50	3.00	4.00	4.00	4.50	4.50	8.50	46.00	72.00	95.24	13.29	18.58	1825.99	50.73	30.00	15.00	5.66
102/124-1	31.00	3.00	3.50	4.00	5.50	4.50	7.50	45.00	83.00	100.00	15.92	19.30	1939.59	49.52	27.58	5.00	3.44
103/125-1	30.50	3.00	4.00	4.00	6.00	4.50	8.00	45.00	69.00	100.00	11.93	17.37	2037.97	48.60	28.75	65.00	16.22
104/126	30.50	3.00	3.50	4.00	5.50	4.50	7.00	46.00	63.00	100.00	15.34	24.75	2402.82	45.49	28.06	10.00	4.52

105/127	30.00	3.00	3.00	4.00	5.00	4.00	6.00	50.00	76.00	100.00	14.02	18.45	1996.34	47.48	31.01	0.00	4.52
106/129-2	30.50	3.00	3.00	4.00	4.00	7.00	6.50	41.00	61.00	100.00	10.15	16.80	1951.69	45.89	26.37	5.00	3.44
107/130-1	30.00	3.00	3.50	4.50	5.50	6.00	8.00	49.00	76.00	100.00	18.42	24.24	2107.94	46.15	27.14	0.00	4.52
108/131-1	30.00	3.00	3.50	5.50	5.50	6.50	7.50	52.00	74.00	100.00	12.44	16.80	1894.36	49.53	29.99	0.00	4.52
109/131-2	30.00	3.00	3.00	5.50	5.00	7.00	4.00	45.00	74.00	100.00	14.23	19.39	1822.45	46.23	31.39	0.00	4.52
110/131-2a	30.00	3.00	3.00	4.00	4.50	4.00	6.00	47.00	77.00	100.00	21.60	28.10	2717.57	46.60	29.43	55.00	16.28
111/132-3	30.00	3.00	3.50	4.00	5.00	5.00	8.00	53.00	73.00	94.12	15.63	21.40	2157.66	50.39	29.61	0.00	4.52
112/133-1	30.00	3.00	3.50	4.00	6.00	4.50	8.00	48.00	66.00	85.29	13.19	19.85	2264.00	46.67	26.17	0.00	4.52
113/134	31.00	3.00	3.50	5.00	6.00	6.00	5.50	35.00	60.00	82.95	12.70	21.20	1873.54	49.03	30.16	0.00	4.52
114/i1-1	31.00	3.00	3.00	4.00	4.00	6.50	5.00	42.00	79.00	95.76	13.98	17.65	1783.08	46.28	28.62	10.00	4.52
115/i2-2	30.50	3.00	3.00	4.00	4.00	4.50	6.00	49.00	75.00	100.00	16.01	21.10	2163.63	45.54	27.37	0.00	4.52
116/i3-1	30.00	3.50	3.00	4.50	5.00	7.00	6.50	53.00	77.00	100.00	13.67	17.77	1812.26	46.43	29.06	5.00	3.44
117/i3-2	30.50	3.00	3.00	4.00	4.00	4.00	5.50	51.00	72.00	90.63	16.26	22.70	2444.80	48.26	28.05	0.00	4.52
118/i4-1	30.50	3.00	3.50	4.00	5.00	4.00	7.00	52.00	68.00	96.34	14.93	21.95	2329.97	47.85	28.73	0.00	4.52
119/i4-2a	30.50	3.50	3.00	4.50	4.00	7.00	4.00	42.00	69.00	100.00	14.18	20.53	2347.38	51.36	31.51	0.00	4.52
120/i4-3	30.50	3.00	3.00	4.00	4.00	5.50	4.50	38.00	64.00	91.26	11.52	18.05	1938.76	48.56	27.85	0.00	4.52
121/i5-1	30.50	3.00	3.00	4.00	4.00	7.50	4.00	38.00	70.00	92.98	13.78	19.71	1830.77	46.96	27.63	0.00	4.52
122/i5-2	30.50	3.50	3.50	5.00	6.00	6.00	8.50	48.00	64.00	100.00	10.36	16.19	1715.77	47.48	29.48	0.00	4.52
123/i6-1	30.50	3.00	4.00	5.00	6.00	4.50	8.00	42.00	67.00	90.82	14.35	21.55	2331.92	48.96	30.37	0.00	4.52
124/i7	30.00	3.00	3.50	4.00	4.50	5.00	5.00	44.00	67.00	100.00	12.89	19.30	2016.38	48.30	32.23	5.00	3.44
125/i7-3	30.00	3.00	3.00	4.00	4.00	5.50	6.00	42.00	71.00	100.00	13.68	19.25	2027.54	43.89	27.71	0.00	4.52
126/i8-2	30.00	3.00	3.00	4.50	5.00	6.50	7.50	50.00	68.00	100.00	12.63	18.65	1921.76	46.31	29.85	0.00	4.52
127/i9-1	30.50	4.00	4.00	5.00	5.00	7.50	6.50	44.00	63.00	91.23	14.15	22.35	2363.61	48.00	26.81	10.00	4.52
128/i9-2a	30.50	4.00	3.50	5.50	5.00	8.00	6.50	40.00	58.00	86.47	12.26	21.65	2160.94	47.87	26.24	5.00	3.44
129/i9-2b	30.00	4.50	3.00	6.50	5.00	8.50	6.00	44.00	61.00	88.81	13.87	22.65	2177.18	45.79	24.84	5.00	3.44
130/i16-1	30.50	3.50	3.00	5.50	4.50	8.00	5.00	46.00	77.00	100.00	15.50	20.10	2087.76	46.66	27.25	20.00	6.30
131/i16-2	30.00	3.00	4.00	5.50	5.50	7.50	8.00	44.00	68.00	100.00	7.55	11.03	1558.48	46.80	25.59	0.00	4.52

132/i17-2a	30.00	3.00	3.50	6.50	5.50	8.00	7.00	40.00	73.00	100.00	17.42	23.65	2260.81	45.95	29.37	0.00	4.52
133/i17-2b	30.00	3.00	3.50	5.00	5.00	6.50	7.00	48.00	70.00	100.00	13.30	19.00	2000.53	48.63	31.25	0.00	4.52
134/i26-1	30.50	3.00	3.00	4.50	4.50	5.50	5.50	38.00	77.00	100.00	17.11	22.20	2122.84	47.29	28.71	0.00	4.52
135/i29-1	31.00	3.00	3.00	4.00	4.00	7.00	4.50	38.00	71.00	100.00	12.86	18.10	1891.81	47.74	27.88	65.00	10.13
136/i29-2a	30.00	3.00	3.00	5.00	4.00	4.50	4.50	50.00	80.00	100.00	16.92	21.15	2259.98	47.99	28.53	5.00	3.44
137/i29-2b	29.50	3.00	3.00	4.00	4.00	5.50	6.50	52.00	87.00	94.55	14.54	16.70	1730.85	45.95	28.79	0.00	4.52
138/i39-1	30.00	3.00	3.00	5.00	4.00	5.00	7.00	44.00	82.00	100.00	16.84	20.58	2276.16	49.64	29.04	0.00	4.52
139/i39-2	30.50	3.00	3.00	4.00	4.00	7.50	4.00	42.00	70.00	83.75	15.28	21.90	2160.22	46.21	31.37	0.00	4.52
140/i39-3	30.00	3.50	3.00	5.50	6.00	7.50	8.00	44.00	73.00	100.00	14.23	19.55	2013.42	50.60	28.49	0.00	4.52
141/ii1-1	30.50	3.00	3.00	4.00	4.00	4.50	4.50	38.00	72.00	94.74	12.70	17.55	1796.05	46.13	27.35	0.00	4.52
142/ii1-2	30.50	3.00	3.00	5.50	4.00	7.50	6.00	50.00	59.00	84.56	11.25	19.20	2114.26	45.19	23.66	0.00	4.52
143/ii2-1	30.50	3.50	3.00	5.50	4.50	7.50	6.50	42.00	68.00	93.96	12.04	17.63	1923.48	47.03	30.57	0.00	4.52
144/ii7-1a	31.00	3.00	3.00	5.00	4.00	7.50	6.50	42.00	78.00	94.85	12.83	16.40	1598.38	44.23	29.12	0.00	4.52
145/ii7-1b	30.50	3.00	3.00	4.00	5.00	5.00	7.50	36.00	67.00	95.05	13.93	20.91	1963.15	48.77	29.32	0.00	4.52
146/ii7-2	30.00	3.00	3.00	4.00	4.00	4.00	4.00	40.00	74.00	93.18	15.05	20.38	2071.48	51.67	28.28	0.00	4.52
147/ii18-1	30.00	3.00	3.00	4.00	4.00	5.00	7.00	44.00	69.00	90.11	14.28	20.80	1946.59	46.47	24.33	0.00	4.52
148/ii18-2	30.50	3.00	3.00	5.00	4.00	8.00	5.50	42.00	66.00	96.50	12.95	19.65	2006.70	49.15	26.74	0.00	4.52
149/ii18-3	30.50	3.00	3.00	5.50	4.00	8.00	5.00	43.00	67.00	94.57	11.76	17.65	1882.09	48.05	28.46	0.00	4.42
150/ii30-1	30.00	3.50	3.00	5.50	4.00	8.00	6.50	45.00	70.00	88.94	19.41	27.47	2720.48	47.63	29.14	0.00	4.52
151/ii33-2	30.00	3.00	3.00	4.50	6.00	5.00	8.50	53.00	73.00	92.41	15.61	21.37	2098.65	47.91	27.38	0.00	4.52
152/ii41-1	30.50	3.00	3.50	5.00	6.00	5.00	8.50	46.00	90.00	100.00	20.63	22.86	2303.01	49.54	27.06	0.00	4.52
153/1-1	30.00	3.50	4.00	5.50	6.00	6.00	9.00	52.00	71.00	94.87	15.81	22.25	2275.93	48.75	27.31	0.00	4.52
154/2-2	30.50	3.00	3.00	5.50	4.00	8.00	4.00	46.00	77.00	97.16	15.44	20.02	2245.99	47.85	25.90	5.00	3.44
155/4	30.00	3.50	3.50	4.50	6.00	8.00	5.50	52.00	81.00	96.67	17.56	21.60	2212.63	48.34	25.26	0.00	4.52
156/5-1	31.00	3.00	3.00	4.50	5.00	8.00	4.50	44.00	73.00	91.47	19.88	27.25	2686.37	46.64	28.88	10.00	4.52
157/6b-2	31.00	3.00	3.50	4.00	6.00	5.00	8.00	41.00	73.00	93.82	19.22	26.25	2767.56	46.36	26.20	0.00	4.52
158/7-1	30.50	3.00	3.00	4.00	6.00	6.00	7.00	50.00	73.00	96.67	17.04	23.50	2375.47	47.07	30.54	0.00	4.52

159/9-1	30.00	3.00	3.50	4.00	6.00	6.00	7.50	36.00	64.00	100.00	14.88	23.80	2465.08	46.85	28.29	0.00	4.52
160/11-1	30.50	3.00	3.00	4.50	4.00	8.00	4.50	44.00	68.00	90.53	13.93	20.65	2240.39	46.21	30.24	75.00	12.80
161/12-1	30.00	3.50	4.00	5.50	6.00	8.00	8.00	39.00	57.00	100.00	12.76	22.85	2463.56	43.08	24.82	35.00	7.25
162/13-1	30.00	3.50	3.50	5.50	4.00	8.00	5.50	47.00	72.00	95.98	18.42	25.60	2785.66	47.17	25.29	0.00	4.52
163/14-1	31.00	4.00	3.50	5.50	5.00	7.00	7.50	50.00	77.00	100.00	19.18	24.96	2455.84	47.96	25.94	0.00	4.52
164/15-2	30.00	3.00	3.00	4.00	4.00	4.00	5.00	54.00	68.00	100.00	13.80	20.22	2243.79	47.03	30.15	0.00	4.52
165/16	30.00	3.00	3.00	4.00	4.00	8.00	5.50	47.00	63.00	91.42	16.21	25.65	2590.13	46.37	29.50	80.00	17.98
166/17-1	30.50	4.00	3.50	4.00	6.00	7.00	8.00	46.00	66.00	97.83	11.84	18.15	1904.59	47.99	30.05	0.00	4.52
167/19	30.50	3.00	3.50	4.50	6.00	6.00	8.00	43.00	74.00	100.00	12.64	17.09	1665.18	46.27	24.36	5.00	3.44
168/21-1	30.50	3.00	3.00	4.00	5.00	5.00	8.00	51.00	71.00	96.70	14.33	20.20	2086.78	46.51	27.29	10.00	4.52
169/24-1a	30.00	3.00	3.00	4.50	5.00	5.50	7.50	50.00	69.00	100.00	19.15	27.70	2781.44	47.81	27.09	10.00	4.52
170/26-2	29.50	3.00	3.00	4.00	4.00	5.00	4.50	57.00	75.00	100.00	16.97	22.64	2215.49	49.33	29.64	5.00	3.44
171/27-3	30.50	3.00	3.00	4.00	5.50	5.00	7.50	52.00	68.00	95.18	14.18	20.90	2161.11	46.60	29.30	5.00	3.44
172/28-1	30.50	3.00	3.00	4.00	5.00	6.50	5.00	48.00	76.00	95.92	12.25	16.13	1680.51	44.55	29.85	60.00	8.26
173/30-1	30.00	3.00	3.50	4.00	5.50	4.50	8.50	45.00	71.40	96.05	17.62	24.55	2666.34	51.60	28.72	0.00	4.52
174/32-1	31.00	3.00	3.00	4.00	5.50	5.00	7.50	46.00	70.00	95.65	17.80	25.45	2499.84	50.24	30.72	0.00	4.52
175/33-1	31.00	3.00	3.00	4.00	4.00	5.50	4.50	50.00	79.00	100.00	18.23	23.11	2343.18	46.22	30.16	0.00	4.52
176/33-3a	30.00	3.00	3.00	4.00	5.00	5.50	7.00	48.00	76.00	95.79	16.16	21.20	2199.55	47.61	30.48	0.00	4.52
177/33-3b	30.00	3.00	3.00	4.00	4.00	4.00	4.50	51.00	74.00	100.00	21.77	29.45	2996.43	48.74	28.29	0.00	4.52
178/51	30.50	3.00	3.00	4.00	4.00	4.00	4.50	47.00	74.00	100.00	17.75	23.95	2563.31	49.03	25.72	10.00	4.52
179/37-2	30.50	3.50	3.50	4.00	4.50	6.50	4.50	43.00	76.00	93.05	12.99	17.05	1913.13	45.98	25.90	0.00	4.52
180/38	30.50	3.50	3.00	5.00	5.50	6.50	7.00	42.00	74.00	100.00	16.74	22.60	2319.67	48.99	27.72	0.00	4.52
181/39-3	30.00	3.00	3.00	5.00	4.00	6.50	5.50	48.00	77.00	100.00	18.33	23.85	2403.27	46.74	31.03	10.00	4.52
182/40	30.50	3.00	3.00	4.00	4.00	4.00	4.00	52.00	72.00	100.00	15.55	21.65	2269.32	45.33	30.59	0.00	4.52
183/41-1	31.00	3.50	3.50	5.00	5.50	6.00	7.50	42.00	70.00	96.39	17.12	24.40	2492.41	45.77	28.34	55.00	18.55
184/42-1	30.50	3.50	3.00	5.00	4.00	7.50	4.00	47.00	76.00	100.00	17.78	23.45	2368.81	49.09	28.34	10.00	4.52
185/43-2	30.50	3.00	3.50	4.50	5.00	7.00	7.00	37.00	52.00	86.49	10.03	19.13	2126.34	46.14	26.52	0.00	4.52

186/45-2	30.00	3.00	3.00	5.50	4.00	7.50	4.50	40.00	78.00	100.00	15.37	19.70	2029.69	46.85	29.73	0.00	4.52
187/46-1	30.50	3.00	3.00	5.00	4.00	7.00	5.00	58.00	83.00	95.07	19.61	23.58	2486.01	48.30	28.03	10.00	7.25
188/48	30.00	3.50	3.50	5.00	5.00	5.00	8.00	46.00	81.00	95.83	18.02	22.30	2271.61	48.83	27.12	35.00	4.52
189/49	30.00	3.50	3.50	4.00	6.00	4.00	9.00	40.00	69.00	100.00	12.10	17.48	1860.37	46.15	26.77	0.00	4.52
190/50-2	30.50	3.50	3.50	5.00	4.50	7.50	4.50	53.00	77.00	100.00	17.21	22.40	2283.70	46.67	25.52	10.00	4.52
191/51-1	30.50	3.50	4.00	4.50	6.00	6.00	7.50	48.00	78.00	100.00	16.18	20.73	2162.98	44.80	28.32	0.00	4.52
192/52-3	30.00	3.00	3.00	4.00	6.00	5.00	7.50	52.00	71.00	85.46	17.22	24.25	2507.19	48.94	29.76	0.00	4.52
193/53-2	30.00	3.50	3.50	4.00	4.00	5.50	4.00	54.00	76.00	93.10	18.29	24.10	2616.23	45.46	26.51	0.00	3.44
194/54-1	30.00	3.50	3.00	5.50	5.00	6.50	7.00	51.00	74.00	100.00	17.02	22.95	2278.28	45.33	26.89	5.00	3.44
195/56-2	31.00	4.00	3.00	5.00	4.50	7.00	6.50	48.00	82.00	100.00	16.28	19.85	2140.15	44.03	26.25	55.00	10.16
196/57-1	30.00	3.50	3.00	6.00	4.00	6.50	6.50	43.00	73.00	100.00	19.88	27.25	2844.54	49.51	28.94	5.00	3.44
197/58-1	30.50	3.00	3.00	4.50	4.00	5.50	4.00	54.00	73.00	100.00	17.66	24.20	2390.48	49.46	29.11	0.00	4.52
198/59-1	30.50	3.00	3.00	4.00	4.00	4.00	4.50	45.00	77.00	93.10	15.86	20.55	2344.67	50.46	27.61	0.00	4.52
199/59-3	30.50	3.00	3.00	4.00	4.50	4.00	5.00	39.00	75.00	100.00	14.43	19.32	2295.14	48.76	25.24	5.00	3.44
200/60-1	30.00	3.00	3.00	4.00	4.50	4.50	5.00	37.00	58.00	94.87	11.31	19.30	2063.34	47.05	29.73	0.00	4.52
201/60-2	30.00	3.00	3.00	3.50	4.00	4.50	5.50	40.00	68.00	84.81	15.24	22.41	2499.14	47.16	28.30	0.00	4.52
202/60	31.00	3.00	3.00	4.00	5.50	4.50	8.00	46.00	71.00	100.00	13.73	19.40	2108.06	46.52	26.04	65.00	10.13
203/60-3	30.50	3.00	3.00	5.00	4.00	6.00	4.00	42.00	80.00	91.15	16.48	20.65	1873.67	46.61	22.84	0.00	4.52
204/62-2	30.00	3.00	3.00	5.00	4.50	6.50	4.00	43.00	75.00	100.00	13.84	18.40	2118.37	46.52	23.44	0.00	4.52
205/64-1	30.00	3.00	3.00	5.50	4.00	7.00	4.00	41.00	80.00	97.50	12.21	15.13	1818.26	44.83	24.21	0.00	4.52
206/65-1	30.50	3.50	3.00	5.00	4.00	7.50	5.50	39.00	65.00	93.75	12.01	18.45	1901.97	46.84	29.81	0.00	4.52
207/67-1	30.50	3.00	3.00	4.00	4.00	5.50	4.50	59.00	81.00	100.00	17.32	21.45	2373.37	48.35	27.76	0.00	4.52
208/63	29.50	3.50	3.00	5.50	4.50	7.50	7.50	53.00	75.00	94.44	14.80	19.75	2043.03	48.12	27.05	0.00	4.52
209/64-3	30.00	3.00	3.00	5.50	4.00	6.50	4.50	41.00	72.00	100.00	17.12	23.85	2510.54	47.52	26.73	90.00	23.39
210/65	30.00	3.00	3.00	4.00	4.00	4.50	4.00	45.00	81.00	95.37	17.05	21.06	2222.06	46.55	31.08	0.00	4.52
211/66	30.50	3.00	3.00	4.00	4.00	5.50	5.00	50.00	72.00	90.70	17.97	25.05	2665.67	48.33	24.84	10.00	4.52
212/68-1	30.50	3.50	3.00	5.00	4.00	7.00	4.00	39.00	80.00	95.45	14.50	18.25	1960.90	44.12	26.29	15.00	5.66

213/69-2	30.00	3.00	3.50	4.50	5.50	5.50	7.50	49.00	76.00	97.22	17.21	22.65	2320.11	45.37	26.67	90.00	27.75
214/70-2	29.50	3.50	3.50	4.00	5.50	5.00	8.00	38.00	72.00	85.12	15.12	21.10	2133.53	46.54	26.51	0.00	4.52
215/71-1	30.00	3.50	4.00	4.00	6.00	5.00	8.00	39.00	68.00	100.00	14.41	21.23	2215.61	46.67	29.49	0.00	4.52
216/72-2	30.00	3.50	3.50	4.50	6.00	5.00	8.00	45.00	74.00	100.00	16.32	22.00	2334.39	49.51	30.92	35.00	10.10
217/73-1	30.00	3.00	3.50	4.00	4.00	5.00	6.00	44.00	52.00	93.55	12.86	25.00	2494.63	45.53	26.65	65.00	10.13
218/74-1	29.50	3.00	3.00	4.00	4.50	5.50	5.00	52.00	76.00	96.84	17.94	23.75	2546.81	48.26	29.63	0.00	4.52
219/75-1	29.50	3.00	3.00	4.00	4.00	4.00	5.00	50.00	82.00	94.06	20.43	24.83	2274.90	45.28	29.44	55.00	16.70
220/76-1	31.00	3.00	3.00	4.50	4.00	6.50	4.00	51.00	76.00	100.00	16.96	22.33	2115.82	47.65	28.31	65.00	15.48
221/77-1	31.00	3.00	3.00	4.00	4.00	4.50	5.50	61.00	86.00	100.00	16.49	19.17	2061.80	44.51	22.10	0.00	4.52
222/78-1	31.00	3.00	3.00	4.00	4.00	5.50	4.50	49.00	71.00	92.55	14.89	20.96	2182.49	45.76	27.25	0.00	4.52
223/79-1	31.00	3.00	3.00	4.00	4.00	4.50	5.50	37.00	69.00	92.59	16.17	23.47	2377.40	48.55	32.60	0.00	4.52
224/80-1	30.00	3.00	3.00	4.00	4.00	4.50	5.50	39.00	67.00	94.44	17.26	25.78	2638.82	46.33	29.96	5.00	3.44
225/82b-2	30.00	3.00	3.00	4.00	4.50	4.00	6.00	42.00	81.00	100.00	17.17	21.21	2268.76	45.29	28.38	0.00	4.52
226/84-1	30.00	3.00	3.00	4.00	4.50	6.00	6.50	46.00	71.00	100.00	17.24	24.33	2563.36	46.50	27.44	15.00	5.66
227/86	30.50	3.00	3.00	4.00	5.50	6.00	7.00	47.00	62.00	100.00	16.89	27.33	2842.73	46.57	26.13	0.00	4.52
228/87	30.50	3.00	3.00	4.00	5.50	6.50	7.50	43.00	69.00	100.00	17.98	26.10	2724.72	45.10	26.44	0.00	4.52
229/88	30.00	3.00	3.00	4.00	5.00	6.50	8.00	44.00	81.00	100.00	16.79	20.75	2142.48	49.25	29.19	0.00	4.52
230/89-1	31.00	3.00	3.50	4.00	4.50	5.00	4.50	43.00	77.00	97.67	20.09	26.10	2720.15	49.42	32.83	15.00	5.66
231/90	30.00	3.00	3.00	4.00	4.00	4.00	4.00	40.00	68.00	95.00	14.41	21.18	2263.71	46.28	27.11	0.00	4.52
232/92-1	30.00	3.00	3.00	4.00	4.00	4.00	4.00	52.00	74.00	100.00	19.48	26.36	2709.95	46.03	26.25	45.00	10.31
233/91-2	30.00	3.00	3.00	4.00	4.00	5.50	4.50	60.00	79.00	97.30	22.27	28.18	2915.51	49.49	30.66	5.00	3.44
234/95-1	30.50	3.00	3.00	4.00	4.00	4.50	4.00	50.00	82.00	92.21	20.54	25.00	2511.81	46.49	31.43	0.00	4.52
235/97-1	31.00	3.00	3.00	4.00	4.00	4.00	5.00	49.00	76.00	96.05	19.76	26.00	2752.26	48.41	28.10	0.00	4.52
236/96-2	30.50	3.00	3.50	4.00	4.50	6.00	4.00	47.00	80.00	100.00	23.54	29.50	3030.53	48.23	24.43	35.00	7.25
237/98-1	31.00	3.00	3.00	4.00	4.50	5.50	6.50	48.00	67.00	87.37	20.99	31.31	3193.22	46.51	28.29	55.00	8.27
238/99-1	31.00	3.00	3.00	4.00	4.00	4.50	4.50	45.00	68.00	100.00	17.71	26.10	2764.73	46.89	27.48	0.00	4.52
239/100	31.00	3.00	3.00	4.00	4.00	5.50	4.00	50.00	77.00	91.15	18.01	23.43	2425.01	49.24	28.55	0.00	4.52

240/101-1	31.00	3.00	3.00	4.50	4.00	6.50	4.00	47.00	80.00	100.00	16.32	20.40	2079.45	49.19	30.64	0.00	4.52
241/103-1	30.00	3.50	3.00	4.50	4.00	4.50	4.00	52.00	76.00	94.12	20.15	26.56	2680.52	47.58	27.18	5.00	3.44
242/91-1	31.00	3.50	3.00	5.50	4.00	7.50	4.00	46.00	76.00	95.00	18.13	24.00	2531.14	49.28	29.18	50.00	10.78
243/94-2	30.50	3.00	3.00	4.00	4.00	4.00	4.00	39.00	69.00	100.00	17.96	25.99	2718.00	47.70	30.40	5.00	3.44
244/96-3	30.50	3.00	3.00	4.00	4.00	5.00	5.00	43.00	68.00	100.00	17.98	26.51	2766.16	49.98	30.58	0.00	4.52
245/ii2-1	30.50	3.00	3.00	5.50	4.00	7.50	4.50	45.00	65.00	86.54	17.05	26.08	2721.97	44.99	27.17	30.00	7.00
246/3-2	31.00	3.00	3.50	4.50	5.50	6.00	8.00	46.00	76.00	94.39	17.48	23.00	2360.77	49.62	25.79	0.00	4.52
247/6b-3	30.50	4.00	3.50	5.00	5.50	6.50	8.50	42.00	72.00	89.29	15.50	21.57	2325.44	45.85	26.51	70.00	11.03
248/8-1	30.00	3.50	3.50	5.00	5.50	6.50	7.50	39.00	81.00	100.00	22.41	27.71	2862.24	47.61	28.79	70.00	18.15
249/18b	30.50	4.00	3.50	4.00	5.50	6.50	8.00	41.00	72.00	86.09	13.14	18.32	2184.33	45.64	27.21	0.00	4.52
250/23-1	30.00	4.00	3.50	5.00	4.00	7.50	4.00	56.00	79.00	100.00	19.53	24.29	2408.78	45.94	28.37	0.00	4.52
251/29	30.00	4.00	3.00	5.50	4.00	7.00	4.00	54.00	85.00	92.86	13.87	16.32	1836.69	44.07	26.37	0.00	4.52
252/32-2	30.00	3.00	3.00	5.00	4.00	7.00	4.00	44.00	76.00	97.00	16.49	21.70	2282.27	47.44	26.55	0.00	4.52
253/35-2	31.00	3.00	3.00	4.50	6.00	7.50	7.50	46.00	65.00	100.00	15.83	24.51	2526.87	47.70	28.66	5.00	3.44
254/39-2	31.00	3.00	3.00	4.00	4.00	4.00	4.50	43.00	56.00	100.00	11.33	20.43	2104.88	48.45	28.91	75.00	17.88
255/40	30.50	3.00	3.00	4.50	4.00	7.00	5.00	41.00	68.00	87.18	13.25	19.53	2000.36	47.38	29.75	20.00	6.30
256/44	30.50	3.00	3.00	4.00	5.00	5.00	6.50	43.00	80.00	100.00	22.15	27.69	2886.53	47.56	29.58	10.00	4.52
257/45-3a	30.50	3.00	3.00	4.50	4.00	7.50	4.00	43.00	71.00	95.35	15.30	21.54	2183.56	46.74	28.07	90.00	19.74
258/57-2	30.00	3.00	3.00	5.50	4.00	7.50	4.00	52.00	78.00	100.00	15.36	19.72	1990.41	49.82	29.66	5.00	3.44
259/61-1	30.00	3.00	3.00	5.50	4.00	7.50	4.50	40.00	67.00	100.00	15.14	22.61	2551.99	49.19	31.61	80.00	18.07
260/66	30.50	3.00	3.00	5.00	4.00	6.50	7.50	45.00	63.00	94.12	14.09	22.40	2323.47	45.07	26.01	30.00	7.00
261/81-1	30.50	3.00	3.00	4.50	5.00	4.50	7.50	54.00	62.00	95.06	14.04	22.75	2294.44	45.38	28.78	0.00	4.52
262/83-3	30.50	3.00	4.00	4.50	6.50	4.50	8.00	45.00	73.00	90.22	19.79	27.15	2815.70	46.55	30.71	0.00	4.52
263/85	31.00	3.00	4.00	4.00	6.50	4.00	8.50	46.00	77.00	100.00	17.52	22.70	2335.13	45.18	30.56	20.00	6.30
264/102-1	30.00	3.00	4.00	4.00	6.50	4.00	8.50	38.00	71.00	100.00	14.26	19.89	1634.80	48.30	28.69	10.00	4.52
265/81-1	30.00	3.00	4.00	4.00	6.00	4.00	9.00	41.00	84.00	100.00	14.41	17.20	1793.51	47.24	27.72	65.00	11.83
266/83-3	30.50	3.00	4.00	4.00	6.00	4.50	8.50	36.00	65.00	89.02	13.19	20.40	2079.82	44.63	27.37	50.00	11.74
267/85	30.50	3.00	3.50	4.00	6.00	4.00	8.50	38.00	73.00	100.00	14.94	20.40	2116.02	48.49	30.30	90.00	37.85
268/102-1	30.00	3.00	3.50	4.00	6.00	4.00	8.50	41.00	69.00	90.91	15.86	22.96	8197.72	48.05	30.10	20.00	6.30
TAG-24	30.00	3.00	4.00	5.50	6.50	7.00	9.00	46.00	73.50	97.25	14.29	19.45	2047.58	45.38	25.60	0.00	4.52

GPBD-4	30.00	0.00	0.00	3.00	3.00	3.00	3.00	42.00	77.00	91.88	21.14	27.46	2782.35	48.25	31.40	15.00	5.66
SEm	0.34	0.22	0.25	0.45	0.37	0.67	0.54	3.16	5.31	4.35	1.40	1.36	73.24	0.94	0.88	0.48	0.21
CD@1%	1.26	0.83	0.91	1.66	1.36	2.45	1.99	11.55	19.36	15.86	5.10	4.96	267.91	3.44	3.23	1.77	0.77
CD@5%	0.95	0.63	0.69	1.26	1.04	1.86	1.51	8.77	14.73	12.06	3.88	3.77	203.32	2.62	2.45	1.35	0.58

GENETIC ANALYSIS ON SEED DORMANCY IN GROUNDNUT (*Arachis hypogaea* L.)

YALLAPPAGOUDA B. N.

2011 DR. P. V. KENCHANAGOUDAR
MAJOR ADVISOR

ABSTRACT

Pre-harvest sprouting in groundnut (*Arachis hypogaea* L.) seeds belonging to subspecies *fastigiata* is undesirable. Since it leads to substantial loss of seeds, both in quantity and quality. A short period of dormancy is therefore desirable in the sub-species to reduce such losses. Evaluation of fresh seed dormancy was conducted for two seasons to determine the intensity and duration of dormancy in mapping population wherein 268 RILs lines developed from crosses between the moderately dormant parent GPBD-4 and non dormant parent TAG-24.

The intensity of dormancy ranged from 0 to 100% in summer season. Whereas in *kharif* season ranged 0 to 90%. There was large variation in the intensity of dormancy which could be related to genetic differences between the entries tested. When intensity of dormancy is considered the RIL no. 165, 259, 160, 172, 209, 254, 213, 247, and 248 recorded very high values above 70 per cent in two seasons. While RIL no. 84, 89, 110, 195, 257 and 267 fluctuated widely for intensity of dormancy over seasons. The variation for dormancy in terms of duration as revealed by G 70 estimates was subsequently large as compared to the intensity of dormancy among 268 dormant RILs. The RIL no. 5, 40, 84, 165, 183, 209, 213, 248, 254, 259 and 265 were found to have more than two weeks of dormancy (G 70) in all the two seasons. A period of 2-3 weeks of dormancy was exhibited by RIL no. 5, 30, 40, 84, 110, 165, 183, 219 and 267 during Kharif and RIL no. 5, 40, 84, 89, 165, 172, 267 and 183 during summer. The study has given evidence that for seed dormancy in this mapping population is controlled by duplicate recessive area.