

**EVALUATION OF RICE GENOTYPES IN ACIDIC AND
NEUTRAL SOILS OF NORTHERN HILLS OF
CHHATTISGARH**

M. Sc. (Ag.) THESIS

by

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**DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL
CHEMISTRY
COLLEGE OF AGRICULTURE
FACULTY OF AGRICULTURE
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
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**EVALUATION OF RICE GENOTYPES IN ACIDIC AND
NEUTRAL SOILS OF NORTHERN HILLS OF
CHHATTISGARH**

Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

Sonali Harinkhere

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CERTIFICATE-I

This is to certify that the thesis entitled “**Evaluation of rice genotypes in acidic and neutral soils of northern hills of Chhattisgarh**” submitted in partial fulfillment of the requirements for the degree of “**Master of Science in Agriculture**” of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Sonali Harinkhere** under my guidance and supervision. The subject of the thesis has been approved by Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by her.

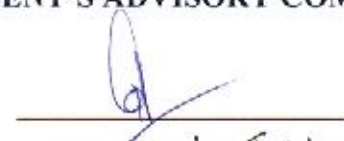


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CERTIFICATE – II

This is to certify that the thesis entitled “**Evaluation of rice genotypes in acidic and neutral soils of northern hills of chhattisgarh**” submitted by **Sonali Harinkhere** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the **Department of Soil Science and Agricultural Chemistry** has been approved by the external examiner and Student's Advisory Committee after oral examination.

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Sonali Harinkhere
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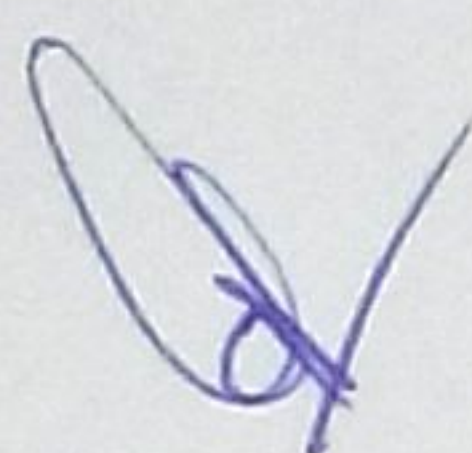
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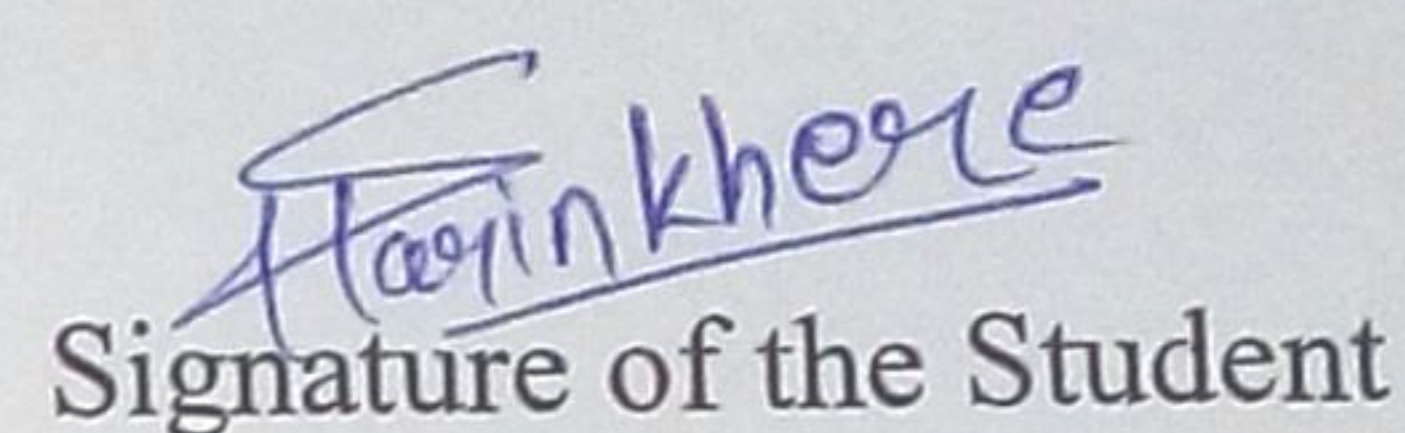
@	At the rate of
Al	Aluminum
B	Boron
CG	Chhattisgarh
Cu	Copper
Ca	Calcium
Ca ²⁺	Calcium ion
cm	Centimeter
°C	Degree Celsius
dS m ⁻¹	Desi Siemens per meter
DTPA	Diethyl triamine penta acetic acid
<i>et al.</i>	and co-worker/and others
<i>etc</i>	Etcetera
EC	Electrical conductivity
Fe	Iron
Fig.	Figure
H ⁺	Hydrogen-ion
ha ⁻¹	Per hectare
<i>i.e.</i>	That is
G	Gram
Kg	Kilogram
K	Potassium
min.	Minutes
Mg	Milligram
Mg ²⁺	Magnesium ion
mm	Millimeter
Mn	Manganese
N	Nitrogen
nm	Nanometer
OC	Organic Carbon
pH	Logarithm of the reciprocal of the H ⁺ ion activity
ppm	Parts per million
P	Phosphorus
%	Per cent
S	Sulphur
S. No.	Serial number
Km ²	Kilometer Square
<i>Viz</i>	That is to say / in other words
Zn	Zinc

THESIS ABSTRACT

- a) Title of the Thesis "Evaluation of rice genotype in acidic and neutral soils of northern hills of Chhattisgarh"
- b) Full Name of the Student Sonali Harinkhere
- c) Major Subject Soil Science and Agricultural Chemistry
- d) Name and Address of the Major Advisor Dr. V. K. Samadhiya, Scientist, Department of Soil Science and Agricultural Chemistry, CoA, I.G.K.V., Raipur (C.G.)
- e) Degree to be Awarded Master of Science in Agriculture (Soil Science and Agricultural Chemistry)

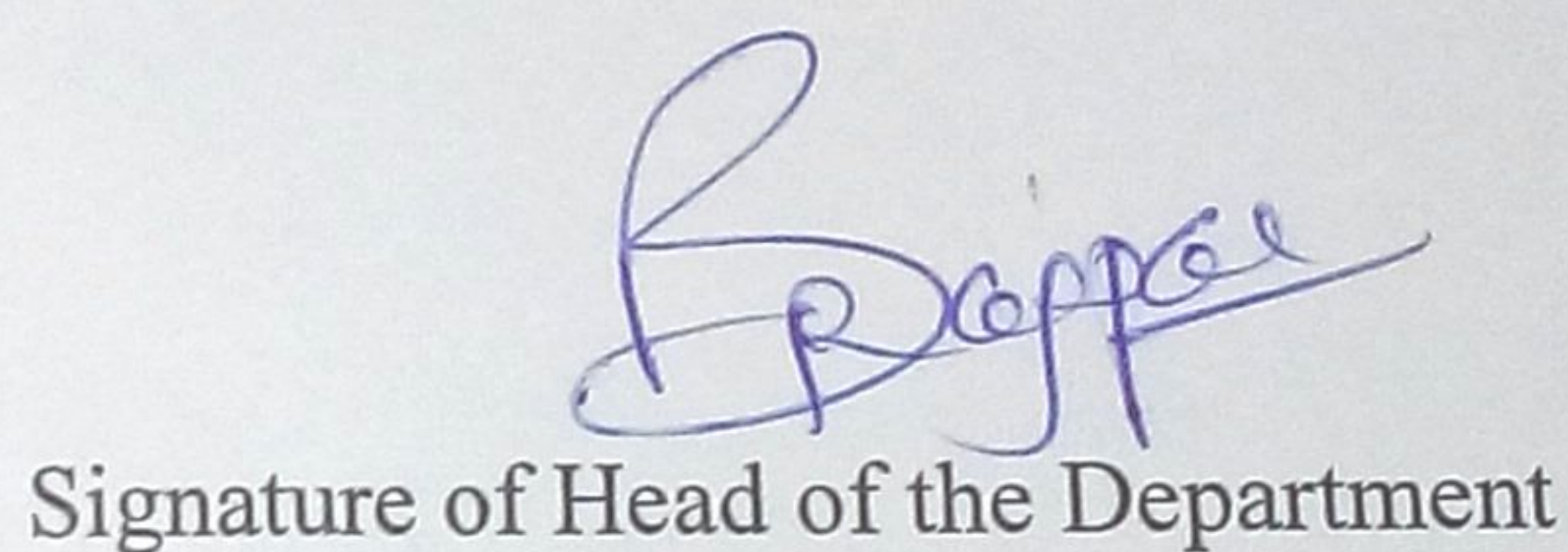


Signature of Major Advisor



Signature of the Student

Date: 22/07/2015



Signature of Head of the Department

ABSTRACT

Field experiments entitled on "Evaluation of rice genotypes in acidic and neutral soils of northern hills of Chhattisgarh" were conducted during *kharif* 2014 at Research Farm RMDCARS and farmers field at village Ajirma, Ambikapur (C.G.). The experiments were laid out in a randomized block design with three replications and twelve treatments of genotypes *viz.*, V1(Indira Maheshwari), V2 (R- 1688-2150-5-2060-1), V3 (Sampada), V4 (Mahamaya), V5 (Bamleshwari), V6 (Vijeta), V7 (Shyamla), V8 (R 1661-605-84-1), V9 (R 304-34), V10 (Durgeshwari), V11 (Karma Mahsuri) and V12 (MTU 1010) enriched with (GRD) General Recommended Doses of Fertilizers.

The results of comparative study conducted in acidic and neutral soil shows that the cultivar Mahamaya is comparatively good among the genotypes tested with respect to yield and yield components and nutrient uptake. Whereas, the lowest yield loss due to soil acidity was recorded in genotype Karma Mahsuri (13.32%) and the highest yield loss percentage was observed in genotype R 304-34 (52.58%). The nutrient status of acid soil was poor in comparison to neutral soil. Acidic soils, one of the handicapped soils of northern hill zone of Chhattisgarh produces poor rice yield. Normal rice production in these soils by means of amelioration is costly. Considering rice genotypes/cultivars to be a better option for getting more yields.

शोध ग्रंथ सारांश

शोध का शीर्षक	: छत्तीसगढ़ के उत्तरी पहाड़ी क्षेत्र में अम्लीय और उदासीन मृदा में धान के जीनप्रारूपों का मूल्यांकन
विद्यार्थी का पूरा नाम	: सोनाली हरिनखेरे
मुख्य विषय	: मृदा विज्ञान एवं कृषि रसायन
मुख्य परामर्शदाता का नाम एवं पता	: डॉ. वी. के. समाधिया, सहायक प्राध्यापक, मृदा विज्ञान एवं कृषि रसायन विभाग, कृषि महाविद्यालय, इं. गां. कृ. वि., रायपुर (छ.ग.)
उपाधि	: एम.एस. सी. (कृषि)

मुख्य परामर्शदाता के हस्ताक्षर

दिनांक 22/07/2015

विद्यार्थी के हस्ताक्षर

विभागाध्यक्ष के हस्ताक्षर

सारांश

छत्तीसगढ़ के उत्तरी पहाड़ी क्षेत्र में अम्लीय और उदासीन मृदा में धान के जीनप्रारूपों का मूल्यांकन राजमोहिनी देवी कृषि महाविद्यालय एवं अनुसंधान केंद्र के शोध प्रक्षेत्र और अजिरमा ग्राम अम्बिकापुर छत्तीसगढ़ के किसान के प्रक्षेत्र में खरीफ 2014 के दौरान किया गया। प्रयोग में 12 अलग-अलग जीनप्रारूप वी 1 (इंदिरा माहेश्वरी), वी 2 (आर 1688-2150-5-2060-1), वी 3 (संपदा), वी 4 (महामाया), वी 5 (बम्लेश्वरी), वी 6 (विजेता), वी 7 (श्यामला), वी 8 (आर 1661-605-84-1), वी 9 (आर 304-34), वी 10 (दुर्गेश्वरी), वी 11 (कर्मा माहसूरी) और वी 12 (एमटीयू 1010) जीनप्रारूपों को यादृच्छिक ब्लॉक डिजाइन में तीन प्रतिकृति में लगाया गया।

अम्लीय तथा उदासीन मृदा के तुलनात्मक अध्ययन से प्राप्त परीणाम यह प्रदर्शित करते हैं कि महामाया किस्म सभी जीनप्रारूपों में उपज, उपज घटकों तथा पोषक तत्वों के अवशोषण में अपेक्षाकृत अधिक उपज देती है। जबकि मृदा की अम्लीयता के कारण होने वाली उपज हानि जीनप्रारूप कर्मा माहसूरी (13.32 प्रतिशत) में दर्ज की गई तथा उच्चतम उपज हानि प्रतिशत जीनप्रारूप आर -304-34 (52.58 प्रतिशत) में देखा गया। उदासीन मृदा की तुलना में अम्लीय मृदा के पोषक तत्वों का स्तर कम पाया गया। छत्तीसगढ़ के उत्तरी पहाड़ी क्षेत्र की अम्लीय मृदा धान की कम उपज देने वाली समस्याग्रस्त मृदा है। मृदा सुधारकों का उपयोग करके इन मृदाओं में धान का उत्पादन करना महंगा है। इसे ध्यान में रखते हुए धान की ऐसी प्रजाति को एक अच्छे विकल्प के रूप में अधिकतम उत्पादन हेतु क्षेत्र विशेष के लिए उपयोग में लाया जाना चाहिए।

CHAPTER- I INTRODUCTION

Rice (*Oryza sativa* L) is a member of *Poaceae* family, is one of the most consumed cereal grain in the world constituting the dietary staple food of 2.7 billion people rice production occupies 150 million ha of cultivable land, producing 573 million tonnes with an average productivity of 3.83 tonnes ha⁻¹.

India is the largest rice growing country, while China is the largest producer of rice. Rice is grown under so diverse soil and climatic conditions that it is said that there is hardly any type of soil in which it cannot be grown including alkaline and acidic soils. Rice crop has also got wide physical adaptability. Therefore, it is grown from below sea-level (Kuttanad area of Kerala) upto an elevation of 2000 metres in Jammu & Kashmir, hills of Uttaranchal, Himachal Pradesh and North-Eastern Hills (NEH) areas.

Chhattisgarh state is divided into three agro-climatic zones viz., Chhattisgarh Plains, Bastar Plateau and Northern Hills zone covering 51.0%, 28.0% and 21.0% of the geographical area, respectively. Chhattisgarh is popularly known as “rice bowl of India” because state has maximum area under rice cultivation during *kharif* and contribute major share in national rice production. It has geographical area of 13.51 million ha of which 5.9 million ha is under cultivation (Anonymous, 2011).

Rice is a good source of dietary energy and 100 gm of rice contains 129 calories which consist of fat 0.28gm, carbohydrates 27.9 gm, protein 2.66 gm in addition it also contains 1% calcium, 1% iron, 3% magnesium and 5% Vitamin B₆.

Acid soil contains approximately 30% of the world’s total land area, and it has been estimated that over 50% of the world’s potential arable lands are acidic. Acid soils that limit crop production have extended more than 40% of the world’s arable soils. In India total geographical area of 328.73 million hectares and about 17.93 million ha area is under soil acidity (Anonymous, 2010).

In India, acid soils are found in the Himalayan region, eastern and north eastern plains, peninsular India, and coastal plains under different agro-climatic situations (NBSSLUP, Nagpur). The states that have large areas under degraded

acid soils include Arunachal Pradesh, Chhattisgarh, Kerala, Assam, Manipur, Nagaland, Mizoram, Meghalaya, Uttarakhand, Madhya Pradesh and Jharkhand. (Roy, 2014).

The production potential of acid soils is generally low which may be due to various soil related constraints or in other words infertility of soils (Mandal, 1997). A low soil pH, poor base saturation, low active clay, high degree of aluminum saturation and low level of microbial activity are some of the common factors causing poor fertility status of acid soil.

Aluminium toxicity is the primary growth-limiting factor for plants in acid soils (Foy, 1992). It is most severe in soils with low base saturation and poor in Ca and Mg thereby leading to a reduction in rice yield. Severe acidic condition (pH <3.5) includes toxic levels of Aluminum (Al), Manganese (Mn), Zinc (Zn), Copper (Cu) and Iron (Fe), as well as deficiencies of several essential mineral elements such as phosphorus (P), Sulphur (S), Calcium (Ca), and Magnesium (Mg). Phosphorus (P) being the major limiting nutrients on acid soil.

Rice has been reported to be the most Al-tolerant cereal crop (6-10 times more tolerant than other cereals) under field conditions and capable of withstanding significantly higher concentrations of Al than other major cereals. About 13% of global rice production occurs in acidic soils. Rice cultivars differ in their tolerance for iron toxicity and the selection of rice cultivars with superior iron tolerance is an important component of research for reducing iron toxicity. Genetic differences in adaptation to and tolerance for iron toxic soil conditions have indeed been exploited for developing rice cultivars with tolerance for iron toxicity (Gunawardena *et al.* 1982, DeDatta *et al.* 1994).

Toxicity of aluminium is a serious problem in sub-soils, which are difficult to amend with lime. In addition, liming sub-soils is prohibitively expensive. Roots in limed soils tend to be confined to surface layers due to subsurface acidity (Al toxicity), which restricts the ability of plants to explore a larger soil volume for water and nutrients, and leads to reduced yields.

Inter- and intra-specific plant differences for tolerance to soil acidity/Al toxicity have been reported (Foy, 1984). Differences in yield and nutrient uptake have been related to root development (elongation and absorption), translocation,

and shoot demand per unit of nutrient absorbed (Baligar et al., 1993 Fageria *et al.*, 1990; Foy, 1984). Cultivars with a high nutrient efficiency ratio when grown under acid soil stress, may have an advantage in adapting to mineral-stressed acid soils of the tropics, and genotypes that are efficient nutrient utilizers might be useful in breeding for more efficient cultivars for mineral-stressed ecosystems.

Rao, (2001) reported that the improvement of the genetic Al resistance is a less costly complementary approach, especially for low-fertility agricultural systems. Thus, selection of genotypes with high adaptability to the acid soils is a promising alternative (Foy, 1996). Such adaptation broadly includes tolerance to high levels of Al and Mn and capacity to grow normally under poor nutrient soil conditions. There exist, wide genetic variability among and within the species for tolerance of acid stress conditions (Foy *et. al.* (1993). So crop tolerance of low soil pH has become extremely important which need evaluation. These discoveries will open new avenues and enhance our understanding which economically solution of limited crop production in acidic soil. Nutrient interaction in crop plants is probably one of the most important factors affecting yields of annual crops (Fageria *et al.* (1997). It can be measured in terms of crop growth and nutrient concentrations in plant tissue. Soil, plant and climatic factors can influence interaction. Interactions vary from nutrient to nutrient, from crop species to species and sometimes among cultivars of the same species.

Looking to this fact, the present investigation entitled, “**Evaluation of rice genotypes in acidic and neutral soils of northern hills of Chhattisgarh**” was carried out with the following objectives:

1. To study the performance of different rice genotypes under neutral and acidic soil conditions.
2. To estimate the nutrients uptake by rice genotypes in both the soil conditions.
3. To assess the fertility status of the soil.

CHAPTER II

REVIEW OF LITERATURE

2.1 Yield and yield attributing characters of paddy

2.2 Nutrient uptake by rice genotypes under both soil conditions

2.3 Physico-chemical properties of acid soil and neutral soils

2.4 Fertility status of the soil.

2.1 Yield attributing characters

Can and Lang (2004) conducted study on identification of rice genotypes adapted to adverse soils in mekong delta and found that OM576 offered the highest yield, but not significantly different to AS996 (check). OM576 expressed its high potential on tillering and well adapted to acid sulfate soils in Soc Trang, Kien Giang provinces.

Kuchanur *et al.* (2006) conducted an experiment in saline Vertisols of Tungabhadra Command area to evaluate rice (*Oryza sativa* L.) genotypes for salt tolerances during wet season (*kharif*) 2000,2001 and 2002, under natural saline soils having EC in the range of >8 dS/m and pH around 8. Eleven rice genotypes, viz. Pokkali, CSR 13, CSR 22, CSR 27, IET 15420, IET 15681, IET 16153, IET 16154, IET 16638, IET 16640, and IET 16650 were evaluated along with IR 30864 (salinity check), BPT 5204 and IR 64 (yield checks). Among the varieties screened, CSR 22 recorded consistently higher yields indicating its ability to withstand salinity. It recorded 29% more yield when compared with IR 30864 (saline check variety) and 76% more yield than the BPT 5204, a popularly cultivated variety in the command.

Can and Lang (2007) conducted research under salinity condition in Cau Ngang District. Testing varieties IR71830-3R-2-2-3, IR73055-8- 3-1-3-1, IR73571- 3B-5-1, IR73571-3B-9-2 grew well and obtained higher yield than check variety (AS996). It indicated that OM6043, OM6036, OM6040, OM6038 performed higher yield than check. The other yield trials were conducted under phosphorous deficient condition with ten promising rice varieties. Results showed that OM4668 and OM2818 obtained the highest yield.

Nayak *et al.* (2008) evaluated 65 genotypes for their tolerance capacity to iron toxicity in a typical iron toxic soil of Bhubaneswar, Orissa Rice genotypes irrespective of their duration showing score value between 1 to 2 produced normal yields and those having score between 7 to 9 yielded the minimum. Genotypes Kalinga- III, Udayagiri, Konark and Panidhan under extra early, early, medium and late durations, respectively produced significantly higher yields at different score scales than their respective duration groups.

Fageria *et al.* (2010) evaluated dry bean genotypes for growth, yield components and phosphorus use efficiency and concluded that grain yields and yield components were significantly increased with P fertilization and interspecific genotype differences were observed for yield and yield components. The grain yield efficiency index (GYEI) was highly significant quadratic association with grain yield. Shoot dry weight, number of pods per plant, 100-grain weights and number of seeds per pod was having significant positive association with grain yield. Hence, grain yield of dry bean can be improved with the improvement of these plant traits by adopting appropriate management practices.

Hafeez *et al.* (2010) conducted an experiment to evaluate the rice genotypes for zinc use efficiency. Six rice (*Oryza sativa* L) genotypes were tested at two (0 and 15 Kg ha⁻¹) levels of zinc. Genotypes differed significantly in grain yield and its components. Based on the grain yield efficiency index, genotypes were classified as efficient, medium efficient and most inefficient. The most zinc efficient genotype was: MR 106 and medium efficient were Seri Malaysia Dua, MR 220 and MR 219. The most inefficient genotypes were MR 211 and Bahagia.

Krishnamurthy *et al.* (2010) evaluated twenty eight pre-released promising rice varieties and hybrids were for their grain yield, and response to graded level of applied phosphorus in low soil-P fertility states calcareous *vertisol*. Among rice culture, four distinct patterns in grain yield response were observed with eight rice cultures at 0 P-level, six rice cultures at medium P-fertility level (20-30 kg P₂O₅ ha⁻¹) where existing higher grain yield response, while five recorded higher grain yields and yield response only at higher P-level of 50-60 kg P₂O₅ ha⁻¹ (65-93 kg grain kg⁻¹ P₂O₅) compared to other (16-66 kg grain kg⁻¹ P₂O₅).

Fukrei *et al.* (2011) selected a core set of germplasm used for genetic analysis of yield and nineteen other component traits. The results indicated the core set of germplasm contained high genetic variability. The broad sense heritability and genetic advance as percentage of mean indicated that panicle weight and grain yield/plant are the two most important yield components and selection based on these traits would be very effective in upland rice grown under acid soil conditions.

Kamara *et al.* (2011) reported the response of four rain-fed lowland New Rice for Africa (NERICA) varieties (NERICA-L-12, NERICA-L-41, NERICA-L-42 and NERICA-L-56) and a popularly grown *Oryza sativa* (ITA 150) to nitrogen (0, 30, and 100 kg N ha⁻¹). Nitrogen application increased rice grain yield and yield components with the highest grain yield obtained at 100 kg N ha⁻¹. Average across N rates, NERICA –L-12 and NERICA-L- 41 produced higher grain yield than the others. The least grain yield was produced by IT 150, suggesting that it is not suitable for production in the lowland ecologies.

Michael *et.al.* (2012) evaluated seven genotypes of soybean under varying pH conditions identify that the genotypes varied considerably in the agronomic and yield traits at the different pH values. The traits were greatly reduced at soil pH <5.5 and, it is increased progressively with increase in the pH up to 6.0.

Khan *et al.* (2014) evaluated 24 rice varieties under natural saline condition (salinity block) and normal field condition. The varieties were found significant under saline condition are Pokkali, Basmati 198 and Sathra 278 whereas IR36, Shaheen Basmati, Basmati 2000, Basmati 370, Basmati 6129, IR-6, KSK-133, TN-1, IRP-2 were categorized as salt susceptible varieties based on grain yield data.

Fageria *et. al.* (2015) evaluated thirty genotypes grain yield was 3.5 percent lower at low acidity treatment (with lime) compared to high acidity treatment (without lime); however, difference was not significant. High grain yield at high acidity levels indicated upland rice genotypes' tolerance to soil acidity. Some genotypes, such as BRSGO Serra Dourada and Primavera CL, produced five times more grain yield compared to genotype AB082022 at high acidity level. Similar differences were also found among some genotypes in grain yield at low acidity level. Fifty-three percent of the genotypes produced lower yield at low acidity level

compared to high acidity level. These results suggested that mechanisms of genotype adaptability to acidic soils for grain production are different at different acidity levels.

2.2 Nutrient uptake by rice genotypes under both soil conditions

Baligar *et al.* (1993) evaluated the genotypic differences in sorghum for uptake, inhibition, influx into roots and transport to shoot for nutrients at three levels of soil Al saturation (2, 41, 64%). Overall shoot nutrient uptake, influx into roots and transport showed a significant inverse correlation with soil Al saturation and shoot Al concentration, and a significantly positive correlation with shoot and root dry weight. The nutrient uptake parameters differentiated genotypes into most and least efficient categories at various levels of soil Al saturation. The nutrient uptake parameters showed significant differences with respect to soil Al saturation, genotypes, and their interactions. Fageria *et al.* (1989) studied growth and nutrient utilization by alfalfa (*Medicago sativa* L. cv. Arc) and common bean (*Phaseolus vulgaris* L. cv. Carioca) grown in an acid soil adjusted to eight levels of soil acidity by addition of lime and concluded that Ca and Mg concentration and uptake increase with lime rates for both legumes but were consistently higher in common bean than alfalfa over all lime levels. Shoot concentration of P, K and S in alfalfa increased with lime levels greater than 2 g kg⁻¹. K uptake by common bean was not significantly different across all the lime rates even though shoot K concentration decreased with increasing lime rates.

Baligar *et al.* (1997) shows that Al-tolerant maize genotypes have great potential for increasing dry matter yields at phytotoxic Al levels in soils, partly because they have higher efficiency of utilization of absorbed essential nutrients, particularly P. Such intraspecific diversity in growth and nutrient use efficiency could be exploited in breeding programs to develop cultivars that have high tolerance to soil acidity. The greenhouse technique used appeared to be reliable for separating maize genotypes into Al-tolerant and -intolerant types.

Fageria and Baligar (1997) conducted an experiment to evaluate the growth and P-use efficiency of 20 upland rice and found that plant height, tillers, shoot and root dry weight, shoot-root ratio, P concentration and uptake in root and shoot and

P use efficiency were significantly affected by level of soil P as well as genotype. Shoot weight and P uptake in shoot were found to be the plant parameters most sensitive to P deficiency.

Fageria and Baligar (1999) conducted five greenhouse experiments to evaluate responses of common bean (*Phaseolus vulgaris* L.), lowland rice (*Oryza sativa* L.), corn (*Zea mays* L.), soybean (*Glycine max* L. Merr.), and wheat (*Triticum aestivum* L.) to mean soil pH values of 4.9, 5.9, 6.4, 6.7, and 7 on an Inceptisol. Relative dry matter yield (DMY) of shoots of all the crops tested was significantly affected by soil pH. Based on the quadratic response optimum pH for maximum relative dry matter yield of wheat was 6.3, for soybean 5.6, for corn 5.4, for common bean 6 and for rice 4.9. This showed that crops responded differently to soil acidity. Among the crops tested, rice was the most tolerant and wheat was the most intolerant to soil acidity. On an average concentration of calcium (Ca) and potassium (K) in the plant shoots increased quadratically with increased soil pH except K concentration in the shoots of corn and soybean decreased. Magnesium (Mg) concentrations in the shoots of common bean and wheat decreased with increasing soil pH but in lowland rice, corn, and soybean increased quadratically with increasing soil pH. Phosphorus (P) concentrations in the shoots of common bean, wheat, and corn was increased but in lowland rice and soybean decreased with increasing soil pH. With few exceptions, most of the micronutrients concentrations decreased with increasing soil pH.

Fageria (2002) conducted experiment to determine the influence of Zn, Mn and Cu on shoot dry matter yield and uptake of macro and micronutrients in upland rice, common bean and corn. Six greenhouse experiments were conducted using a Dark Red Latosol (*Typic Haplustox*). Zinc increased yield of rice, Mn increased yields of corn and bean and Cu improved yields of rice and bean. Uptake of N, Ca, and Cu in rice was decreased by zinc treatment. In common bean, uptake of N, Mg, and Cu was increased by zinc application, whereas, uptake of P was decreased. Manganese increased uptake of Mg, Zn and Fe and decreased uptake of Ca, in corn. Uptake of K, Zn and Mn was increased and uptake of P and Cu was decreased by Mn application, in bean. Copper had positive and negative

interactions in the uptake of macro and micronutrients, depending on crop species and nutrients involved.

Fageria *et al.* (2010) conducted a greenhouse experiment and that found grain yield and yield components and N uptake parameters were significantly affected by N and genotype treatments. Regression analysis showed that plant height, shoot dry weight, number of panicles per pot, number of grains per panicle, grain harvest index, N uptake in shoot and grain were having significant positive relation with grain yield. Agronomic efficiency of N (grain yield/unit of N applied) and N utilization efficiency (physiological efficiency X apparent recovery efficiency) were significantly different among genotypes. These two N use efficiencies were having significant quadratic relationship with grain yield. Soil pH, exchangeable soil Ca and base saturation were having significantly positive association with grain yield. However, soil extractable phosphorus (P), potassium (K), hydrogen (H⁺), aluminum (Al) and cation exchange capacity were having significantly negative association with grain yield.

Zhao and Shen (2010) investigated that ammonium enhances Al resistance of rice compared with nitrate. Al does not inhibit ammonium uptake of Al-resistant rice cultivar but does that of the Al-sensitive rice cultivar, and Al-resistant rice cultivar exhibits higher ammonium uptake rate under Al stress compared with the Al sensitive cultivar. Al resistance in rice is positively correlated with ammonium utilization or negatively correlated with nitrate utilization.

Michael *et al.* (2012) screened seven genotypes of soybean (*Glycine max* (L) Merrill) for acid tolerance under varying soil pH conditions at the experimental research farm of the University of Nigeria for two years. Nsukka was identified the acid tolerant genotypes using some yield traits like no. of nodules per plants, no. Of pods per plant, pod weight per plant, test weight and yield . The results revealed that the genotypes varied considerably in the agronomic and yield traits at different pH values. The soil pH, genotype and their interactions had significant effects on most of the traits evaluated in both planting seasons. The traits were greatly reduced at pH < 5.5 and, it increased progressively with increase in the soil pH up to 6.0.

Lestari *et al.*(2014) Seven sorghum genotypes that were used in this study included 4 sorghum lines of [ICRISAT] collection (150-21-A, 5-193-C, 10-90-A, 150-20-A), 1 local sorghum (WHP), and 2 national varieties (Numbu, UPCA). Numbu is a known as an acid soil tolerant variety and was used as positive control. Our results showed that WHP genotype had significantly higher plant height and panicle length, and similar number of leaves, shoot fresh weight, root fresh weight, and yield that of Numbu. In contrast, 150-20-A genotypes had significantly lower plant height, number of leaves, shoot fresh weight, root fresh weight, and shorter panicle than that of WHP genotype. It can be concluded that from agronomy character of the seven sorghum genotypes used in this study, WHP and Numbu could be classified as acid soil tolerant genotypes while 150-21-A and UPCA genotypes were sensitive to acid soil.

2.3 Physico-chemical properties of acid soil

Ponnamperuma *et al.*(1996) studied the influence of redox potential and partial pressure of carbon dioxide on the pH values of 35 diverse rice soils (pH range between 3.6 and 9.4) from the Philippines, Taiwan and Vietnam. The soils were held in flooded condition in pots in the greenhouse and changes in soil solution pH, redox potential and partial pressure of carbon dioxide were monitored for 16 weeks. The results showed that the pH values of alkali and calcareous soils decreased and those of acid soils increased to a fairly stable range of 6.7 to 7.2, 12 weeks after flooding.

Sharma *et al.* (1990) studied various forms of acidities i.e. exchangeable, pH- dependent and total acidity. The electro statically bonded (EB)-H⁺ and EB-Al⁺³ acidities comprised 21 and 79 percent of exchangeable acidity, whereas pH-dependent and exchange acidities comprised 71 percent of total acidity.

Karyotis *et al.* (2005) examined nutrients status and properties of acidic soils and found that cation exchange capacity was extremely low and organic carbon is poor in the sandy soils. Available phosphorous and exchangeable K⁺ was low indicating a crucial problem of soil fertility. Among the plant available micronutrients, DTPA extracted manganese was most abundant element, while their total content extracted by 4 M HNO₃ ranked as follows: Fe>Mn>Zn>Cu.

Copper (DTPA) was low and manganese was extremely high in Kaimbu. Iron content varied greatly, while decreased zinc was observed in Mbeere.

Patton *et al.* (2005) examined different soils samples collected from the different land use patterns viz. low land soils and forest area of Dimapur district, Nagaland for different form of acidity like exchangeable acidity, total potential acidity and lime requirement. Exchange acidity and exchangeable aluminum had significant negative correlation with soil pH.

Dolui *et al.* (2010) examined the nature of acidity as influenced by lime in major soil series of Nagaland and also assessed the relationships with soil properties and found that the contributions of exchangeable acidity to total potential acidity were low. This indicated the presence of a relatively higher proportion of exchangeable acidity in Longsamtang series as compared to other soil series because of high acidity and it is due to monomeric Al^{3+} . Electrostatically bonded, $EB-H^+$ and $EB-Al^{3+}$ acidities constituted 90.1 and 9.6% of exchangeable acidity, while $EB-H^+$, $EB-Al^{3+}$, exchangeable and pH-dependent acidities comprised 1.3, 12.5, 13.7 and 85.5% of total potential acidity.

Obura *et al.* (2010) surveyed Kenyan, Africa acid soils of 11 sites of maize growing region and found that soils are low in pH, P, effective cation exchange capacity, and relatively high aluminum saturation. Low plant nutrient reserves, particularly phosphorus, and likely aluminum toxicity seem to be the major limitations for sustainable agricultural use and management of these soils.

Pati and Mukhopadhyay (2010) found that the distribution of the DTPA extractable Fe, Mn, Cu and Zn in different pedons under *Terai* situations of West Bengal, India to be governed by the forms of soil acidity. The availability of nutrients varied with the soil depth and with different forms of acidity. Significant correlations of extractable acidity and total potential acidity with the extractable Cu^{2+} and Zn^{2+} were observed for the given soils. The distribution of the forms of acidity with depth of soils varied on account of the changing accumulation of exchangeable bases at different depths in soils.

2.4 Fertility status of the soil

Sahrawat *et al.* (1993) conducted a research on *Alfisols* and *Ultisols* of the humid-forest and savannah zones in West Africa showed that upland rice is a robust crop, possessing a wide range of tolerance to acid-soil conditions. Recent research at WARDA showed also that acid soil tolerance can be enhanced through interspecific *Oryza sativa* x *O. glaberrima* progenies, which not only possess increased tolerance of acid-soil conditions, but also have superior overall adaptability to diverse upland environments in the sub-region. Our research on the diagnosis of acid-soil infertility problems on the *Ultisols* and *Alfisols* of the humid savannah and forest zones indicates that P deficiency is the most important nutrient disorder for upland rice.

Swarup and Yaduwanshi (2000) conducted experiment on rice-wheat sequence in *AcquicNatrustalfs* of Karnal. They reported that there is decrease in the available P from an initial value 11.8 to 9.7 kg ha⁻¹ in control plots and further application of 150% recommended NPK and FYM, under integrated use of inorganic and organic fertilizer resulted in increase in content of available P (18.4 kg ha⁻¹) in soil.

Sahrawat (2005) reported that flooding soil is a great equalizer of diversity in chemical fertility of wetland soils. This change is brought about by consumption of acidity in acid soils and the neutralization of alkalinity in alkaline and calcareous soils following flooding. As a result of flooding, the pH of acidic soils increases and that of alkaline soils decreases and the chemical reaction of submerged soils generally stabilizes in the neutral range 8-13. This is the benefit of flooding of soils to rice crop. The convergence of pH to near neutral also affects the availability of plant nutrients mostly in a favourable manner.

Subehia *et al.* (2005) reported that the addition of FYM or lime along with organic fertilizers, not only sustained higher crop yields, but also improved the soil quality as well. Imbalanced use of inorganic fertilizers on the other hand reduced the crop productivity and deteriorated the soil health in terms of increased soil acidity and high P adsorption. The continuous application of chemical fertilizers decreased the soil pH significantly in all the treatments except in the lime-treated

plots. Nitrogen alone (urea) had the most deleterious effect on soil pH. The organic carbon content of the experimental plots increased, in general, due to continuous cropping. Among the available N, P and K, only P showed a significant build up over initial level, except in treatments where in it was not added.

Varalakshmi *et al.* (2005) reported that the available nitrogen, phosphorus and potassium content of soil after the harvest of groundnut and finger millet crops increased significantly over the initial contents. The increase was maximum in the treatment where NPK fertilizers were applied based on soil test values in both the crops. It may be due to sufficient supply of nutrients by applied NPK fertilizers (Rao *et al.* 1987). The highest available nitrogen (356 kg ha⁻¹) content in *Alfisols* after the harvest of finger millet crop was registered with the treatment of package of practices (12.5:25:12.5 N:P:K kg ha⁻¹+7.5t FYM ha⁻¹). In the treatment of package of practices where 100% recommended dose of NPK fertilizer along with 7.5 t FYM ha⁻¹ was applied recorded significantly higher available phosphorus content after groundnut (145 kg ha⁻¹), followed by farmers practice treatment (136 kg ha⁻¹). Similar results were observed with finger millet cropping with the highest available phosphorus recorded (148 kg ha⁻¹) in the treatment of package of practices followed by farmer's practice (139 kg ha⁻¹).

Laxminarayana (2006) study showed that integrated use of organic manures and inorganic chemical fertilizers produced higher and sustainable crop yields were maintained the soil fertility and productivity. Organics and fertilizers are not only complementary but also synergistic since organic inputs had beneficial effects beyond their nutritional components and enhanced the efficiency of the applied mineral fertilizers.

Raut and Mahapatra (2006) studied the integrated uses of organic and inorganic fertilizers and found effective in enhancing the productivity of the rice. Besides, it has beneficial influence on physico-chemical properties of the soil in respect of lowering bulk density and pH and improving the organic carbon as well as available nutrient status of soil in general and N in particular apart from improving N use efficiency in rice.

Fageria and Santos (2008) reported that in Brazilian *Oxisols* there was a linear increase in the Mehlich 1–extractable P when soil pH was raised from 5.3 to 6.9. Similarly, Mansell et al. (1984) and Edmeades and Perrott (2004) reported that in acidic soils of New Zealand, primary benefits of liming occur through an increase in the availability of P. Fageria (1984) also reported that in Brazilian *Oxisols* there was a quadratic increase in the Mehlich 1–extractable P in the pH range of 5.0 to 6.5, and thereafter it was decreased.

Mandal *et. al.* (2013) reported that available NPK content of the soils revealed that at low soil pH, availability of these nutrients was reduced and these values increased with progressive increase in soil pH. Though, soil pH may not directly control N availability to plants but at lower pH mineralization rate for organic matter was reduced due to low microbial activity which may cause poor N availability. Again, solubility of Al⁺³ and Fe⁺³ increased at low pH (<5.5) which fixed a substantial amount of phosphate ions as insoluble Al-phosphate and Fe – Phosphate complex thereby restricting the availability of phosphate to plants.

Sharma (2013) investigated that available N and P contents of the soils under cereals, vegetable, soybean and forest land use patterns ranged from 288.3 to 342.5, 321.1 to 396.3, 394.0 to 451.9 and 372.1 to 509.4 kg ha⁻¹ and 6.5 to 8.8, 7.5 to 10.6, 7.5 to 11.4 and 8.1 to 12.3 kg ha⁻¹ with an average of 316.1, 354.1, 417.0 and 452.7 kg ha⁻¹ and 8.0, 8.7, 9.2 and 10.1 kg ha⁻¹, respectively (Table 1). On the basis of mean available N, soils of all the villages under different land use systems fell under medium category of nitrogen. Medium class of available N indicates that the mineralizable N fraction under such type of climatic condition and acidic environment is rather low.

Kavitha *et. al.* (2015) conducted to evaluate soil fertility status in the eight major agro ecosystems viz., coconut, banana, rubber, paddy, arecanut, nutmeg, pepper and vegetables in Thrissur District, Kerala. For this, a total of 30 panchayats out of 92 were selected representing 6 agro ecological zones in the district. The data on various parameters were categorized into low, medium and high classes based on soil fertility ratings and nutrient index was calculated. Results revealed that soil reaction in the study area varied from strongly acidic to

slightly alkaline with pH values varying from 2.9 to 7.7 among the eight agro ecosystems studied, soil fertility with respect to organic carbon and nitrogen were high in rubber and medium in all others.

CHAPTER-III

MATERIALS AND METHODS

This chapter deals with a concise description of the material used and the technique adopted during the course of investigation. The present investigation entitled “**Evaluation of rice genotypes in acidic and neutral soils of northern hills of Chhattisgarh**” during the *Kharif* season of 2014-2015.

The details regarding materials used and techniques applied during the course of investigation have been described in this chapter.

3.1 Experimental site

A field experiment was conducted in acid soil at the Farmer’s Field, Ajirma village, Ambikapur, District Surguja and in neutral soil at RMD College of Agriculture and Research Station, Ambikapur (C.G.) using different rice genotypes, during *Kharif* season of the year, 2014.

3.2 Geographical situation

Ambikapur is situated in Northern part of Chhattisgarh and lies at 20°08'N latitude and 83°15' E longitude with an altitude of 592.62 m above the mean sea level.

3.3 Climate and weather

The region comes under sub-humid climatic condition. The average annual rainfall of the area is 1400-1600 mm. Major amount of precipitation occurs between June and September (about 3-4 Months) which is the main rice growing season. The hottest and coolest months are May and December, respectively. The detail weekly meteorological data recorded from meteorological observatory during the crops period presented in Fig. 3.1.

32th week is from 6 August 2014 and 46 week is from 18 November 2014

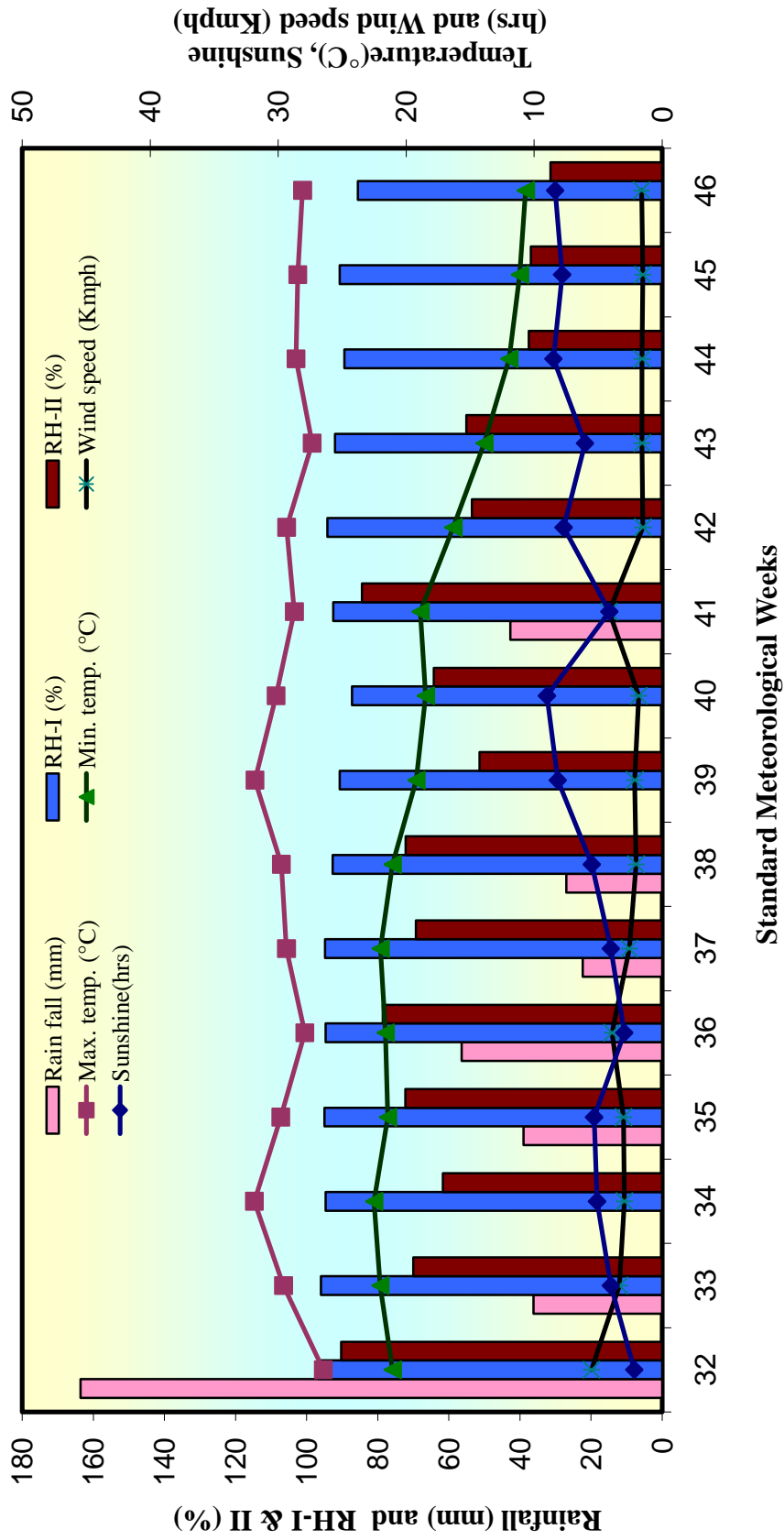


Fig 3.1 : Weekly meteorological observation of August to November 2014 at RMD CARS, Ambikapur

3.4 Soil

The experiment was conducted in two different soil conditions *i.e.*, acidic and neutral. The soil of acidic condition comes under soil order *Inceptisols* also known as *Matasi*. It is sandy loam in texture.

In neutral soil condition comes under soil order *Alfisols* also known as *Dorsa*. It is silty clay loam in texture. Some physico-chemical properties of experimental soil are presented in Table 3.1.

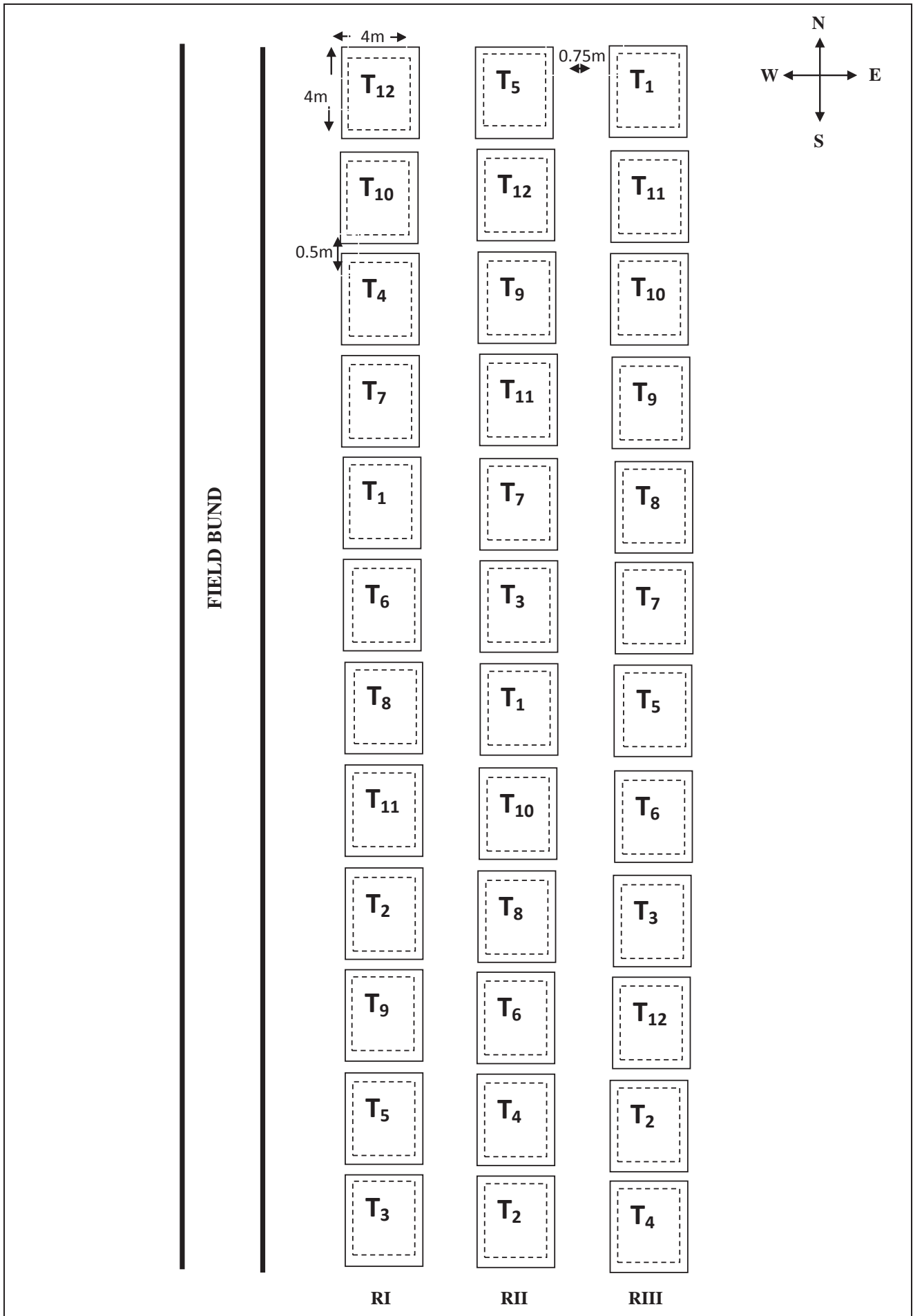
Table 3.1: Initial physico-chemical properties of acid and neutral soil

S.No.	Physico-chemical properties	Acid soil	Neutral soil
		Value	
	<u>Soil texture</u>		
	Sand (%)	54	49
	Silt (%)	28	22
	Clay (%)	18	29
1.	pH(1:2.5)	4.5	6.6
2.	EC(dS m ⁻¹)	0.14	0.18
3.	Organic carbon (%)	0.27	0.51
4.	Available Nitrogen(kg ha ⁻¹)	151.6	232.6
5.	Available phosphorus (kg ha ⁻¹)	9.63	14.89
6.	Available potassium (kg ha ⁻¹)	148.06	318.50
7.	Available Cu (ppm)	1.2	1.60
8.	Available Fe (ppm)	88.85	23.1
9.	Available Mn (ppm)	23.7	11.57
10.	Available Zn (ppm)	0.50	0.6

3.5 Experimental details and layout plan

Field preparation was done by tractor driven implements. The ploughing was done by cultivator, finally the field was puddled by tractor drawn puddler and levelled to create soft condition essential for transplanting of rice. The experiment was laid out in Randomized Block Design including 12 medium duration rice genotypes (Fig.3.2).

Fig: 3.2 Layout plan for Experimental Field



Experimental details:

1. Location : Farmer's field Ajirma village, Ambikapur (Acid soil)RMD College of agriculture and research station (Neutral soil).
2. Season : Kharif 2014
3. Soil : *Alfisols* and *Inceptisols*
4. Crop : Rice
5. Plot size : 4×4m²
6. Total number of genotypes : 12
7. Replications : 3
8. Design : Randomized Block Design
9. Row spacing : 15×20cm
10. Date of Nursery : 09 July 2014
11. Date of Transplanting : 08 August 2014
12. Date of Harvesting : 14 November 2014

Treatment details:

- V1 Indira Maheshwari
- V2 R-1688-2150-5-2060-1
- V3 Sampada
- V4 Mahamaya
- V5 Bamleshwari
- V6 Vijeta
- V7 Shyamla
- V8 R – 1661-605-84-1
- V9 R -304-34
- V10 IGKVR2 (Durgeshwari)
- V11 Karma Mahsuri
- V12 MTU 1010



Fig.3.3 Field view of the experimental site

3.6 Fertilizer application

N, P and K were applied through urea, single super phosphate and murate of potash. The whole amount of P and K was applied at the time of transplanting, while nitrogen was applied in three equal splits applied at transplanting effective tillering and panicle initiation stages. The general recommendation dose of fertilizers were applied was as given below:

N: P₂O₅:K₂O - 100:60:40 NPK kg ha⁻¹

3.7 Pre-sowing and post harvest soil analysis

3.7.1 Soil pH

Soil pH was determined by glass electrode pH meter method (Piper, 1967) in 1:2.5 soil water suspensions as described by Jackson, (1973).

3.7.2 Electrical conductivity

The soil sample used for pH determination was allowed to settle down for 24 hours. The electrical conductivity of the supernatant liquid was determined by conductivity meter as described by Black *et al.* (1965).

3.7.3 Organic Carbon

Organic carbon was determined by Walkley and Black's rapid titration method (1934) as described by Piper (1966).

3.7.4 Available Nitrogen

The available nitrogen in soil was determined by alkaline potassium permanganate method as described by Subbiah and Asija (1965).

3.7.5 Available phosphorus

(Brays 1)

Five gram of air dried soil was taken in a 250 ml conical flask and 50 ml of extractant solution (0.03 N NH₄F in 0.025 N HCl) was added (Bray and Kurtz, 1945). The suspension was shaken for five minutes on a reciprocating shaker. It was filtered through Whatman No. 1 filter paper. Five ml of aliquot of extract was

placed in a 25 ml volumetric flask. Four ml of ascorbic acid solution was added and after 10 minutes blue colour intensity was read at 882 nm (Watanabe and Olsen, 1965).

(Olsen method)

Available phosphorus was estimated by the ascorbic acid method as described by Olsen, (1954). In this method, 2.5 gm soil sample was taken and extracted with 0.5 M sodium bicarbonate at pH 8.5. After extraction from the soil, phosphate in the extract is measured by the reaction of phosphate with ammonium molybdate in an acid medium to form molybdophosphoric acid which is then reduced to a blue coloured complex through reaction with ascorbic acid. Absorbance readings were taken at an 882 nm wavelength using a double beam spectrophotometer.

3.7.6 Available potassium

Available potassium was extracted from the 5 gm soil with the help of suitable extractant neutral normal ammonium acetate by shaking, followed by filtration or centrifugation and K is determined in the extract using flame photometer. It was described by Jackson in 1967. The analysis photometer is based on the measurement of the intensity of characteristic line emission given by the element to be determined.

3.7.7 Available micronutrients

The micronutrients Zn, Cu, Fe and Mn were extracted by using 0.005 M diethylene triamine penta acetic acid, 0.01 M calcium chloride dehydrate and 0.1 M trithanol amine buffered at pH 7.3 (Lindsay and Norvell, 1978) and concentrations were analyzed by atomic absorption spectrophotometer.

3.8 Plant growth and yield analysis

3.8.1 Effective tillers hill⁻¹

Total and effective tillers of marked ten hills of middle row from each genotype were recorded at the time of harvest. After this, average total and effective tillers were determined.

3.8.2 Number of filled grain and unfilled grain panicle⁻¹

Ten panicles selected randomly from harvested produce it was counted from number of filled grain and unfilled grain and then mean was worked out.

3.8.3 Test weight (1000-grain weight)

Different grain samples were collected from each rice genotypes plot. Out of the samples, 1000 grains were counted and weighted by using an electronic balance.

3.8.4 Grain and straw yield

The grain and straw yields were recorded by cutting mid ten hills from each genotype. The bundles were sun dried, weighted, threshed and finally seeds were cleaned and yield was recorded.

3.8.5 Grain Yield Efficiency Index (GYEI)

Grain Yield Efficiency Index was estimated by the following Formula

$$\text{Grain Yield Efficiency Index} = \frac{\text{Yield of the cultivar}}{\text{Average yield of the cultivars}}$$

3.8.6 Yield loss (%)

Yield loss was calculated by following formula

$$\text{Yield loss (\%)} = \frac{\text{Neutral soil yield} - \text{Acid soil yield}}{\text{Neutral soil Yield}} \times 100$$

3.9. Plant chemical analysis

Plant and grain samples were dried at 55°C in an oven for 24 hours and were grinded and used for analysis.

3.9.1 Nitrogen content

Nitrogen content of grain and straw sample was done by taking 0.25 gm uniform prepared sample in digestion tube. 1 gm salt mixture (K₂SO₄ and CuSO₄.5H₂O in the ratio of 10:1) was added in the tube. 05 ml. of concentrated H₂SO₄ acid was added and material was digested at 350 °C in digestion block till

the solution becomes colourless. Nitrogen in digested material was distilled by automatic KEL plus system.

3.9.2 Phosphorus and Potassium

One gram of grain and straw samples was taken in digestion tube and 10 ml of tri-acid mixture (Concentrated HNO₃, HClO₄ and H₂SO₄ in the ratio of 9:4:1) was added. The material was digested at 150 °C in KEL plus digestion block till the material become colourless. The digested material was transferred in to 100 ml volumetric flask by repeated washing with distilled water and made up the volume up to the mark. This digested material was used for the estimation of P and K content analysis as given below

3.9.3 Phosphorus content

Phosphorus content was determined by vanadomolybdo-phosphoric acid yellow colour complex method as described by Jackson (1967). An aliquot of 10 ml was taken, 10 ml of vanado-molybdate yellow reagent was added and volume was made up to 50 ml. After half an hour color intensity was measured by Spectrophotometer at 420 nm.

3.9.4 Potassium content

Potassium content was determined by flame photometer as described by Chapman and Pratt (1961).- An aliquot of 5 ml was taken and made up to volume of 25 ml in volumetric flask and potassium content was determined by flame photometer.

3.9.5 Nutrient uptake

Nitrogen, phosphorus, potassium and micronutrient (Zn, Cu, Fe and Mn) uptake in grain and straw yields were computed by multiplying their respective nutrient contents with yields.

3.10. Statistical Analysis

The experiment was laid out in Randomized Block Design (RBD). The data obtained from various characters under study were analyzed by the method of analysis of variance as described by Gomez and Gomez (1984). The level of significance used in “F” test was given at 5 per cent. Critical difference (CD)

values are given in the table at 5 per cent level of significance, wherever the “F” test was significant at 5 per cent level. The skeleton of analysis of variance and formula used for various estimations are given below:

Table 3.2: The skeleton of the analysis of variance

Source of variation	DF	S.S.	M.S.S.	F cal	F tab	SEM±	CD 5%
Replication (r)	(r-1)						
Treatments (t)	(t-1)						
Error	(r-1)(t-1)						
Total	(rt-1)						

The following formula was used for standard error, critical difference and coefficient of variance estimation.

$$(a) \text{ S.Em } \pm = \sqrt{EMS/r}$$

$$(b) \text{ C.D.} = t_{\text{at error d.f. 5\%}} \times \text{SEd}$$

$$(c) \text{ C.V. (\%)} = \sqrt{EMS/\bar{X}} \times 100$$

Where, r = Number of replication,
t = Number of treatment
d.f. = Degree of freedom
C.D. = Critical difference,
C.V. = Coefficient of variance
S.S. = Sum of square
M.S.S. = Mean sum of square
EMS = Error mean square
S.Em ± = Standard error of mean
GM = Grand mean

CHAPTER-IV

RESULTS AND DISCUSSION

The experimental results of the investigation carried out on “**Evaluation of rice genotypes in acidic and neutral soils of northern hills of Chhattisgarh**” are presented in this chapter and an attempt has been made to explain the important findings by establishing a cause and effect relationship on the basis of available data and literature evidence under following subheads:

- 4.1 Study of yield attributing characters of different rice genotypes in acidic and neutral soils
- 4.2 Paddy yield, straw yield, grain yield efficiency index of different rice genotypes in acidic and neutral soils
- 4.3 Yield losses in rice genotypes under acidic soil condition
- 4.4 Macro-nutrient (N, P and K) uptake by different rice genotypes grown in acidic and neutral soils
- 4.5 Soil fertility status after harvest crop in acidic and neutral soils.

4.1 Study of yield attributing characters of different rice genotypes in acidic and neutral soils

4.1.1. No. of effective tillers hill⁻¹

Number of effective tillers hill⁻¹ was counted at harvest and data are presented in Table 4.1 and Fig. 4.1 and Table 4.2, Fig 4.2. Results showed that in acidic soil varieties Mahamaya showed significantly superior no. of effective tillers hill⁻¹ (7.02) which was followed by MTU 1010, Indira Maheshwari and Karma Mahsuri and the lowest no. of effective tillers was recorded by Shyamla (4.09) whereas in neutral soil Mahamaya (7.93) which is significantly superior and at par with Karma Mahsuri and Bamleshwari. And followed by (R 304-34), Indira Maheshwari and MTU 1010 while the lowest no. of effective tillers hill⁻¹ was recorded by R- 1688-2150-5-2060-1 (4.47).

4.1.2. No. of filled grains panicle⁻¹

The data presented in Table 4.1, Fig. 4.1 and Table 4.2, Fig. 4.2 showed that number of filled grains panicle⁻¹ in acidic soils were found significantly

superior in Bamleshwari (96.80) followed by Mahamaya and MTU 1010 and the lowest no. of filled grains panicle⁻¹ was observed in Shyamla (71.03), whereas in neutral soils Mahamaya (118.28) are independently significantly superior among all the treatment which was further followed by R 304-34, Bamleshwari and Indira Maheshwari and the lowest no. filled grains panicle⁻¹ was showed by R 1661-605-84-1(82.87).

Table: 4.1 Performance of yield attributing characters of different rice genotypes grown in acid soil

Treatments	No. of filled grains panicle ⁻¹	No. of unfilled grains panicle ⁻¹	No. of effective tillers hill ⁻¹	Test Weight (g)
V1- Indira Maheshwari	89.37	15.16	5.74	23.13
V2- R-1688-2150-5-2060-1	79.39	26.23	4.36	19.74
V3- Sampada	80.80	24.03	4.60	18.82
V4- Mahamaya	93.21	13.05	7.02	29.49
V5- Bamleshwari	96.80	21.10	5.80	23.91
V6- Vijeta (MTU 1001)	86.20	24.31	4.55	23.29
V7- Shyamla	71.03	32.26	4.09	18.13
V8- R 1661-605-84-1	80.40	23.23	4.64	18.87
V9- R 304-34	78.10	29.73	4.62	21.19
V10- IGKVR2 (Durgeshwari)	87.13	15.23	5.20	20.37
V11- Karma Mahsuri	83.93	20.36	5.54	18.27
V12- MTU 1010	91.97	18.07	6.42	26.11
SEm±	0.43	1.16	0.12	0.31
CD (P=0.05)	1.26	3.40	0.37	0.93

4.1.3 Test weight

The data presented in Table 4.1 and Table 4.2 and stated that in acidic soil the highest test weight was found in Mahamaya (29.49 g) which was found significantly superior and at par with MTU 1010 and followed by Bamleshwari, Vijeta and Indira Maheshwari and comparatively lowest test weight was found in genotype Shyamla (18.13 g).

In neutral soil, highest test weight was found in Mahamaya (29.53g) which was found significantly superior among all other genotypes followed by MTU

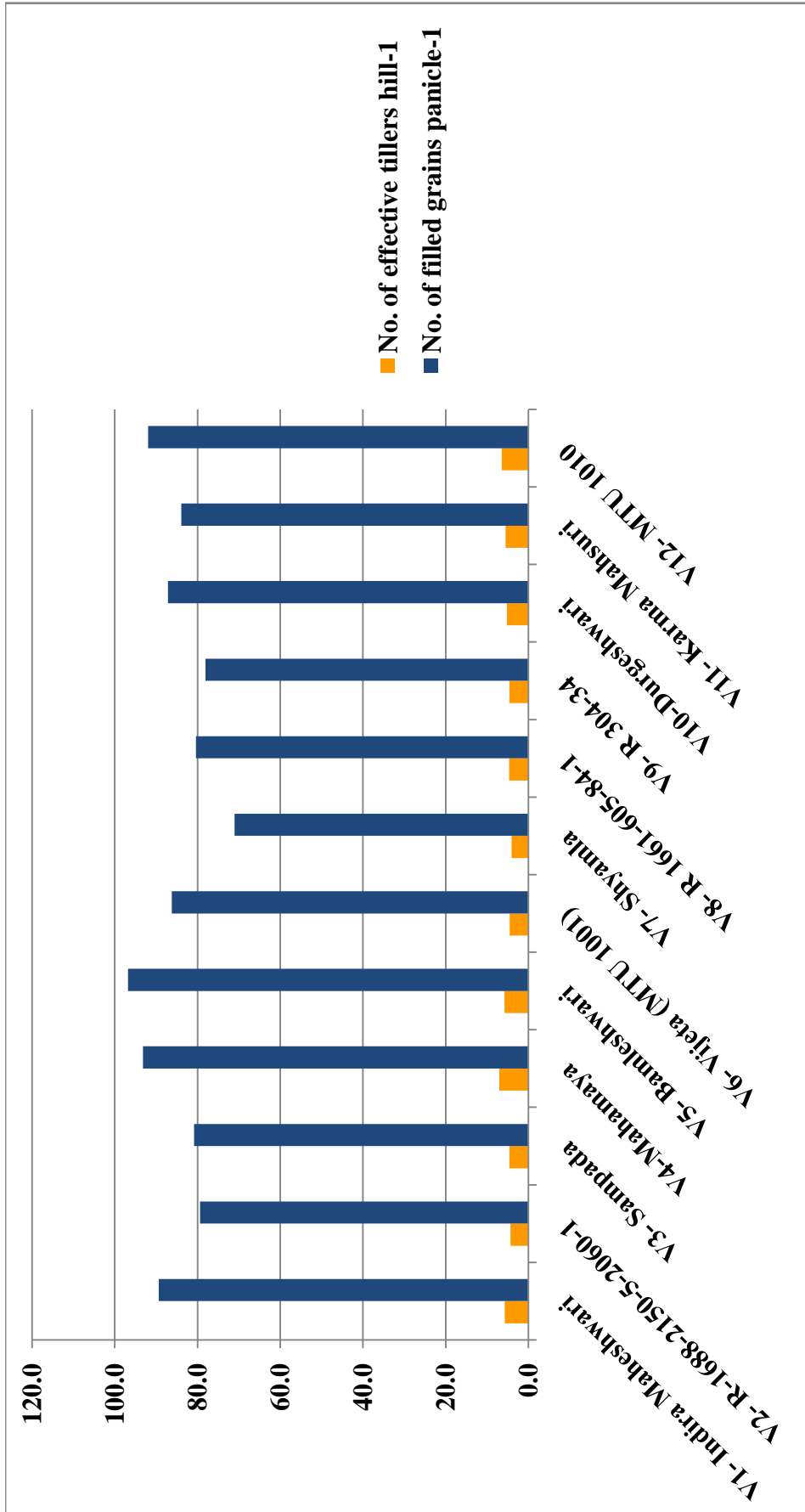


Fig.4.1. Performance of yield attributing characters of different genotypes in acid soil

1010, Bamleshwari, Vijeta and Indira Maheshwari and the lowest test weight was found in Karma Mahsuri (19.64 g).

Table: 4.2 Performance of yield attributing characters of different rice genotypes grown in neutral soil

Treatments	No. of filled grains panicle ⁻¹	No. of unfilled grains panicle ⁻¹	No. of effective tillers hill ⁻¹	Test Weight (g)
V1- Indira Maheshwari	108.79	23.62	6.80	25.54
V2- R-1688-2150-5-2060-1	87.18	25.22	4.47	22.74
V3- Sampada	90.81	29.31	6.33	20.45
V4- Mahamaya	118.28	20.73	7.93	29.53
V5- Bamleshwari	112.85	22.47	7.70	26.08
V6- Vijeta (MTU 1001)	91.27	26.30	6.40	25.68
V7- Shyamla	85.97	31.28	5.32	19.92
V8- R 1661-605-84-1	82.87	29.48	7.30	20.33
V9- R 304-34	113.25	21.93	6.91	23.96
V10- IGKVR2 (Durgeshwari)	90.40	27.28	5.45	21.71
V11- Karma Mahsuri	87.27	27.89	7.77	19.64
V12- MTU 1010	96.20	24.27	6.75	28.90
SEm±	0.37	0.43	0.13	0.38
CD (P=0.05)	1.10	1.27	0.39	1.12

Grovois and McNew (1993) reported that genotypes produced higher number of effective tiller and grain per panicle also resulted in higher grain yield of rice. The yield attributing traits are genetically controlled which vary with genotypes and also influenced by environmental factors. The results of the study were similar as reported in rice by Counce et al. (1996) and in dry bean by Wallace et al., (1972), Fageria et al. (2007) and Sharma and Dadhich (2003).

4.2 Paddy yield, straw yield, grain yield efficiency index of different rice genotypes in acidic and neutral soils

4.2.1 Paddy yield and Straw yield

The data presented in Table 4.3 and Fig. 4.3 showed the performance of different rice genotypes in acidic soil revealed that genotypes Mahamaya,

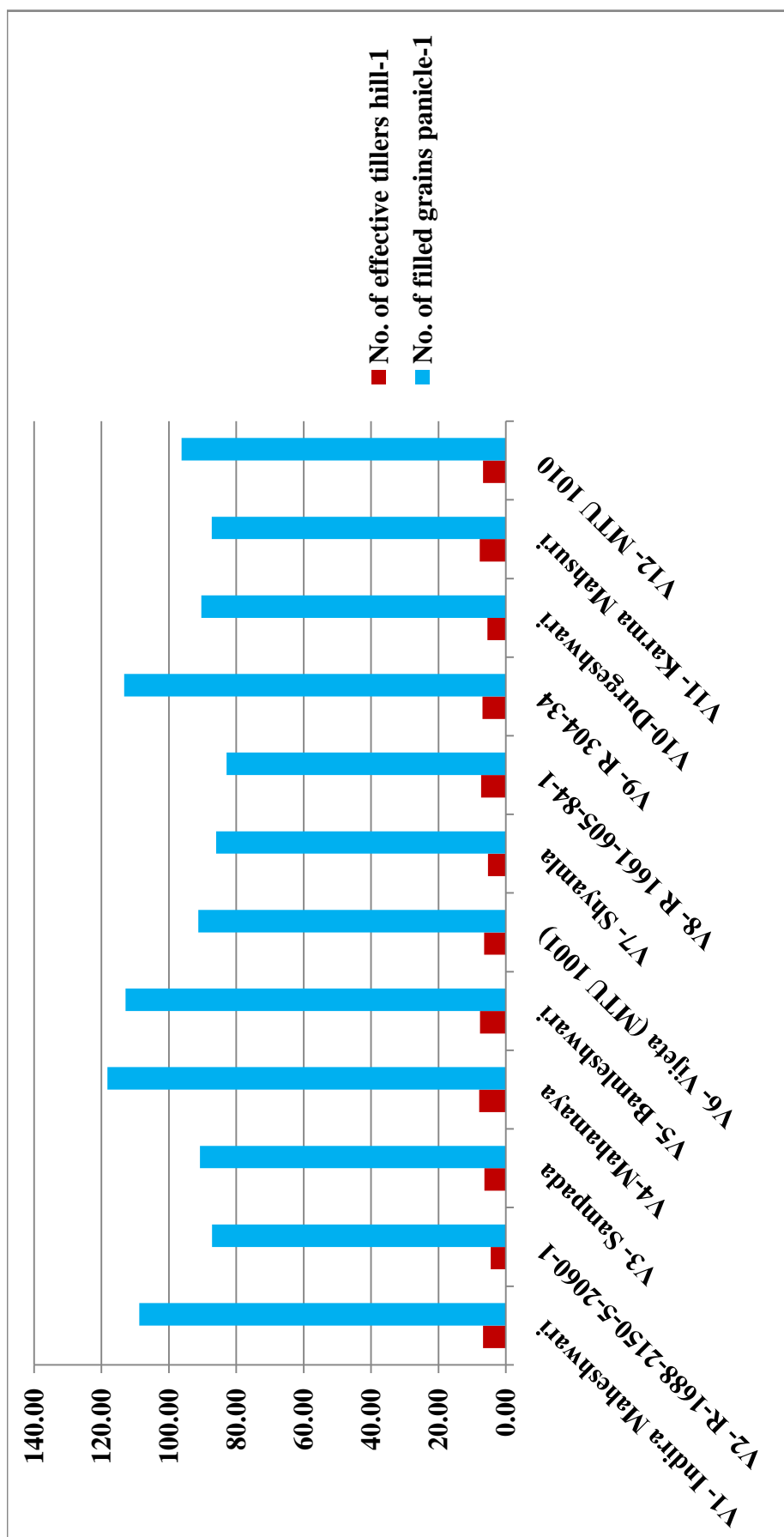


Fig.4.2.Performance of yield attributing characters of different genotypes in neutral soil

Bamleshwari, MTU 1010 and Indira Maheshwari gave significantly higher yield *i.e.*, 39.35, 38.23, 37.83 and 36.96 q ha⁻¹ respectively which was found superior over other genotypes, followed by Durgeshwari and Karma Mahsuri which gave 34.03 and 33.04 q ha⁻¹. Rest of the genotypes did not performed better in relation to yield, and among them the lowest yield was observed in Shyamla 16.81q ha⁻¹.

Table 4.3 Yield performance of different genotypes in acid soils

Treatments	Grain Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)
V1- Indira Maheshwari	36.96	48.05
V2- R-1688-2150-5-2060-1	22.76	36.27
V3- Sampada	25.52	32.79
V4- Mahamaya	39.35	51.87
V5- Bamleshwari	38.23	49.09
V6- Vijeta (MTU 1001)	26.72	37.17
V7- Shyamla	16.81	34.72
V8- R 1661-605-84-1	28.27	42.44
V9- R 304-34	27.16	40.87
V10- IGKVR2 (Durgeshwari)	34.03	45.23
V11- Karma Mahsuri	33.04	46.44
V12- MTU 1010	37.83	47.24
SEm±	0.95	1.47
CD (P=0.05)	2.78	4.33

The result of grain yield of genotypes/cultivars grown in neutral soil given in Table 4.4 and Fig. 4.5 revealed that , genotypes Mahamaya was found significantly superior in respect to yield followed by R 304-34, Bamleshwari and Indira Maheshwari which gave grain yield 59.64, 57.28, 55.79 and 53.78 (q ha⁻¹) respectively followed by the genotypes MTU 1010, Vijeta, Durgeshwari, R-1661-605-84-1, Sampada, and R- 1688-2150-5-2060-1 were found significantly at par and gave grain yield 47.07, 44.81, 43.98, 42.85, 39.20 and 38.58 q ha⁻¹ respectively, while the lowest yield was recorded in neutral soil in two genotypes *i.e.*, Karma Mahsuri 38.12 and Shyamla 32.17q ha⁻¹). Straw yield q ha⁻¹ of all the

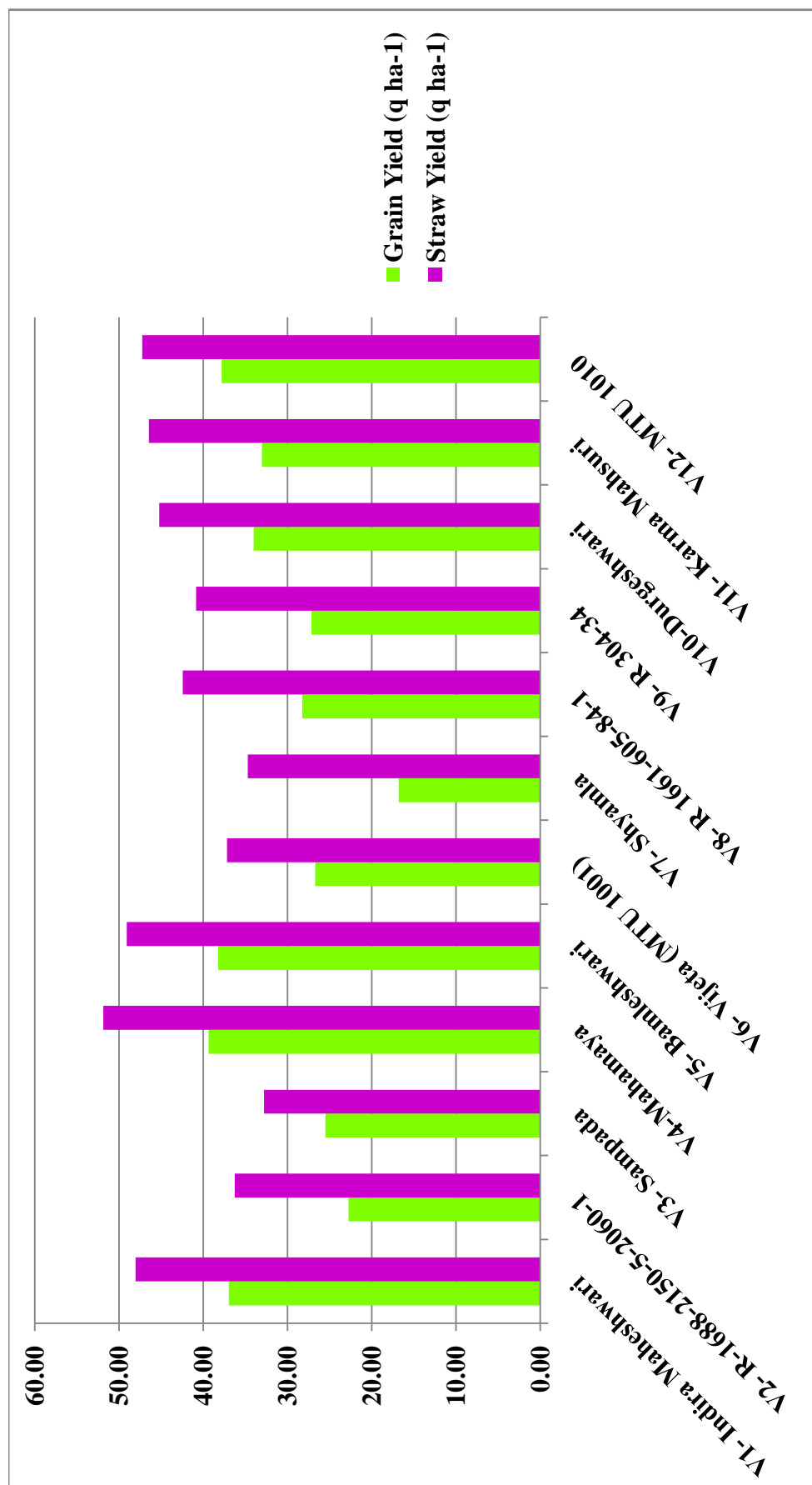


Fig.4.3 Yield performance of different genotypes in acid soil

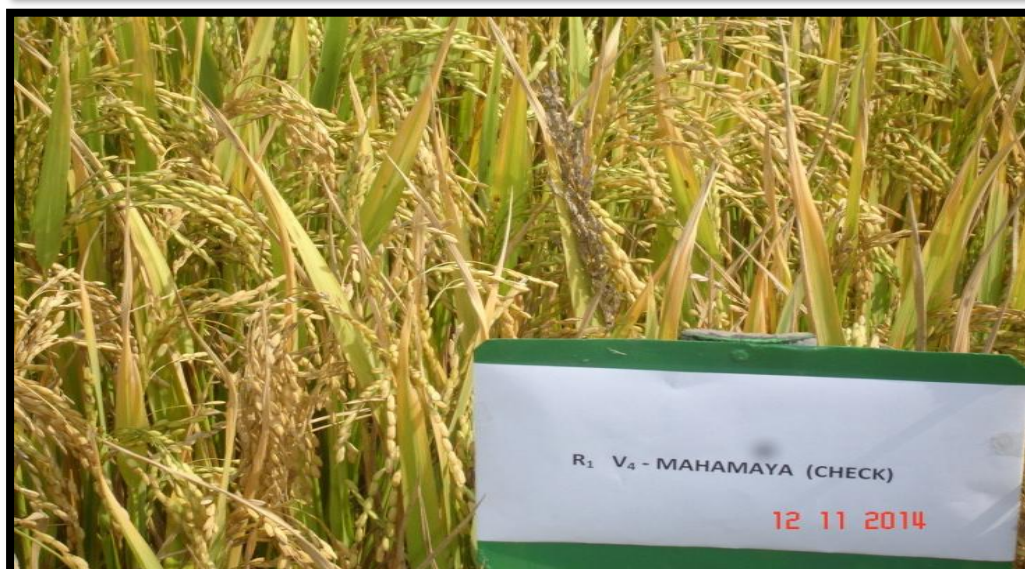




Fig. 4.4. Performance of different genotypes in acid and neutral soils

genotypes were presented in Table 4.3 and 4.5. The findings shows nearly similar results as reported by Solanki (2013).

Table 4.4 Yield performance of different genotypes in neutral soils

Treatments	Grain Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)
V1- Indira Maheshwari	53.78	56.71
V2- R-1688-2150-5-2060-1	38.58	47.69
V3- Sampada	39.20	44.25
V4- Mahamaya	59.64	65.71
V5- Bamleshwari	55.79	59.88
V6- Vijeta (MTU 1001)	44.81	49.14
V7- Shyamla	32.17	39.22
V8- R 1661-605-84-1	42.85	49.79
V9- R 304-34	57.28	62.27
V10- IGKVR2 (Durgeshwari)	43.98	50.62
V11- Karma Mahsuri	38.12	46.46
V12- MTU 1010	47.07	55.61
SEm±	3.00	0.48
CD (P=0.05)	8.82	1.42

Nutrients availability to the crop in acid soil was adversely affected which is also reflected in poor plant growth and reduced yield and yield attributing characters (Table 4.1 and 4.2) of the genotypes. The lower pH of experiment soil also may be responsible for reduced root growth and thereby nutrient availability to plant, and thus reduced plant growth and yield. The findings agree with the results reported by Mossor-Pietraszewska (2003) and Duressa *et al.* (2011). The similar results regarding adverse effect of higher content of Al, Mn and Fe on plant growth and development was also reported by Beegle and Lingenfelter (1995) and in wild barley by Dai *et al.* (2011).

4.2.2 Grain yield efficiency index

Grain yield efficiency index is good tool to categorize the genotypes into efficient and inefficient (Hafeez *et al.* 2010). In acidic soils the overall mean of grain yield efficiency index was found 1.00. It was ranged from 1.29 to 0.55. Among the genotypes the highest grain yield efficiency index was noticed in Mahamaya

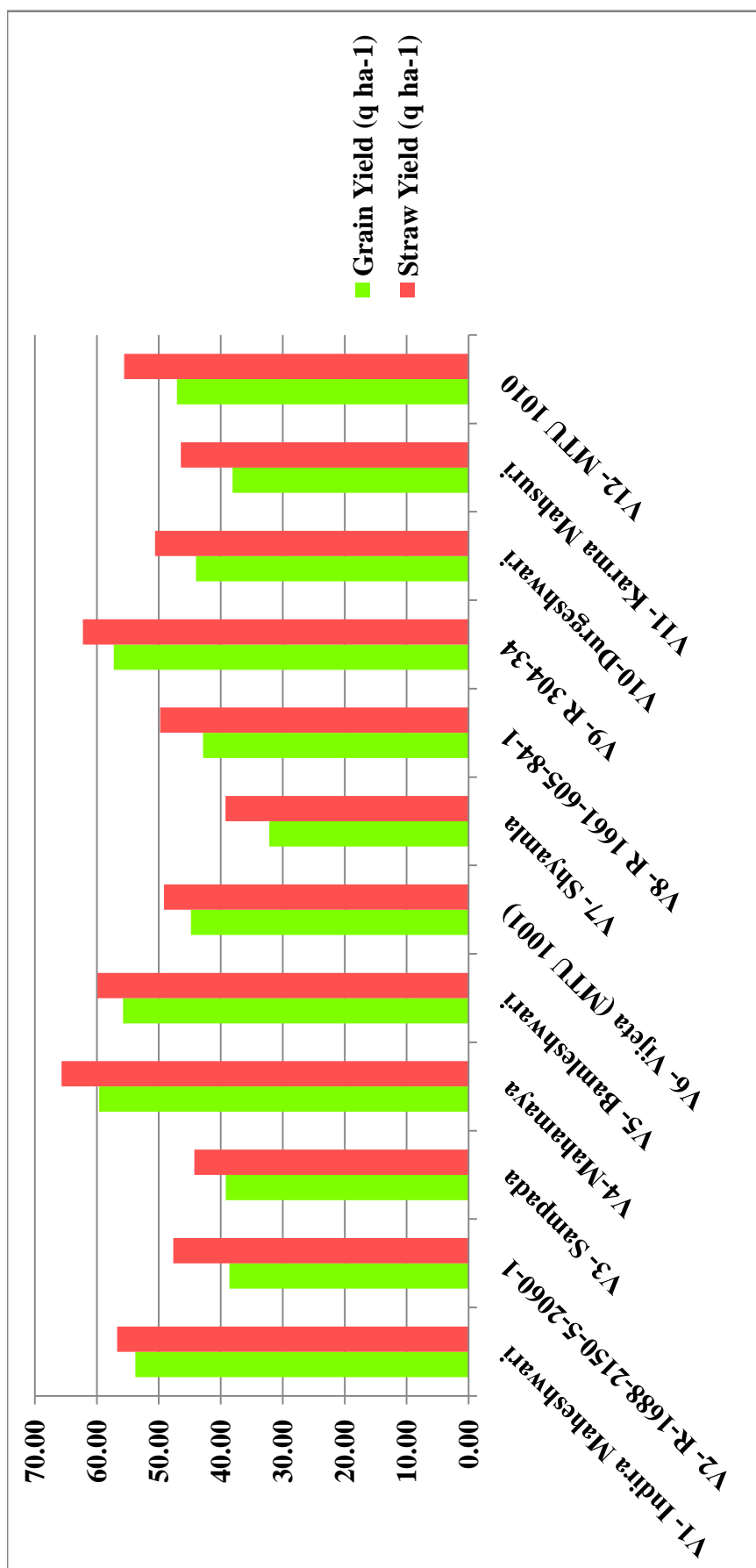


Fig.4.5 Yield performance of different genotypes in neutral soil

followed by Bamleshwari and MTU 1010 and the lowest value was noticed in Shyamla. The similar results were as of acidic soils were also obtained in neutral soils were ranged from 1.29-0.70 and the highest value is noticed in Mahamaya followed by R 304-34 and Bamleshwari and the lowest was noticed in Shyamla. Similar findings were also supported by Sahrawat *et al.* (1993) in which he evaluated Grain yield efficiency index (GYEI = grain yield of the cultivar/mean grain yield of the cultivars) values varied from 0.20 to 1.66.

4.3 Yield losses in rice genotypes under acidic soil condition

Comparitive yield loss percentage on twelve genotypes was studied in two soil conditions (acidic and neutral). Data presented in Table 4.5 stated that lowest yield loss percentage was recorded in genotype Karma Mahsuri (13.32%) whereas highest yield loss percentage was observed in genotype R 304-34 (52.58%), although this genotype was second high yielder in neutral soil (57.28 q ha⁻¹) and in acidic soil showed comparatively, low yield (27.16 q ha⁻¹). It is evidenced from the present results that the genotypes are not suitable for both soil condition, however some rice genotypes *viz.*, Karma Mahsuri, MTU 1010 and Durgeshwari were found acid tolerant and gave better yield and less yield loss percent.

Table: 4.5 Yield losses in rice genotypes under acidic soil condition

Treatments	Yield in acid soil (q ha ⁻¹)	Yield in neutral soil (q ha ⁻¹)	Yield loss (%)
V1- Indira Maheshwari	36.96	53.78	31.27
V2- R-1688-2150-5-2060-1	22.76	38.58	41.00
V3- Sampada	25.52	39.20	34.90
V4- Mahamaya	39.35	59.64	34.02
V5- Bamleshwari	38.23	55.79	31.47
V6- Vijeta (MTU 1001)	26.72	44.81	40.37
V7- Shyamla	16.81	32.17	47.75
V8- R 1661-605-84-1	28.27	42.85	34.02
V9- R 304-34	27.16	57.28	52.58
V10- IGKVR2 (Durgeshwari)	34.03	43.98	22.63
V11- Karma Mahsuri	33.04	38.12	13.31
V12- MTU 1010	37.83	47.07	19.63

The lower yield loss of the genotypes in acid soil may be due to their greater ability to withstand soil acidity and genetically controlled traits. The findings are also in agreement with the work of Foy (1984) and Baligar *et al.* (1987).

4.4 Macro-nutrient (N, P and K) uptake by different rice genotypes grown in acidic and neutral soils

4.4.1 Total N uptake

The data presented in Table 4.6 and Fig.4.6 stated that in acidic soils the maximum N uptake was observed in genotypes showed by Mahamaya (63.22 kg ha⁻¹) which was significantly superior followed by Bamleshwari and MTU 1010. However, the minimum N uptake was recorded in Shyamla (24.34 kg ha⁻¹). As in neutral soil (Table 4.7. and Fig. 4.7) the maximum N uptake was observed in genotype Mahamaya (89.78 kg ha⁻¹) which was significantly at par with R 304-34 and more as compared to Indira Maheshwari and Bamleshwari. Apparently, low N uptake was recorded in Shyamla (60.61 kg ha⁻¹).

Table 4.6 Total N, P and K uptake in different rice genotypes in acid soils

Treatments	Total N uptake (kg ha-1)	Total P uptake (kg ha-1)	Total K uptake (kg ha-1)
V1- Indira Maheshwari	61.72	11.86	79.98
V2- R-1688-2150-5-2060-1	34.67	9.06	54.11
V3- Sampada	36.30	10.84	56.03
V4- Mahamaya	63.22	12.93	87.41
V5- Bamleshwari	58.25	12.09	84.78
V6- Vijeta (MTU 1001)	51.89	11.06	72.18
V7- Shyamla	24.34	7.80	39.12
V8- R 1661-605-84-1	52.03	11.73	67.59
V9- R 304-34	51.42	11.35	62.64
V10- IGKVR2 (Durgeshwari)	56.12	11.76	77.73
V11- Karma Mahsuri	53.72	11.64	77.39
V12- MTU 1010	60.20	12.39	80.98
SEm±	0.38	0.04	0.36
CD (P=0.05)	1.13	0.13	1.08

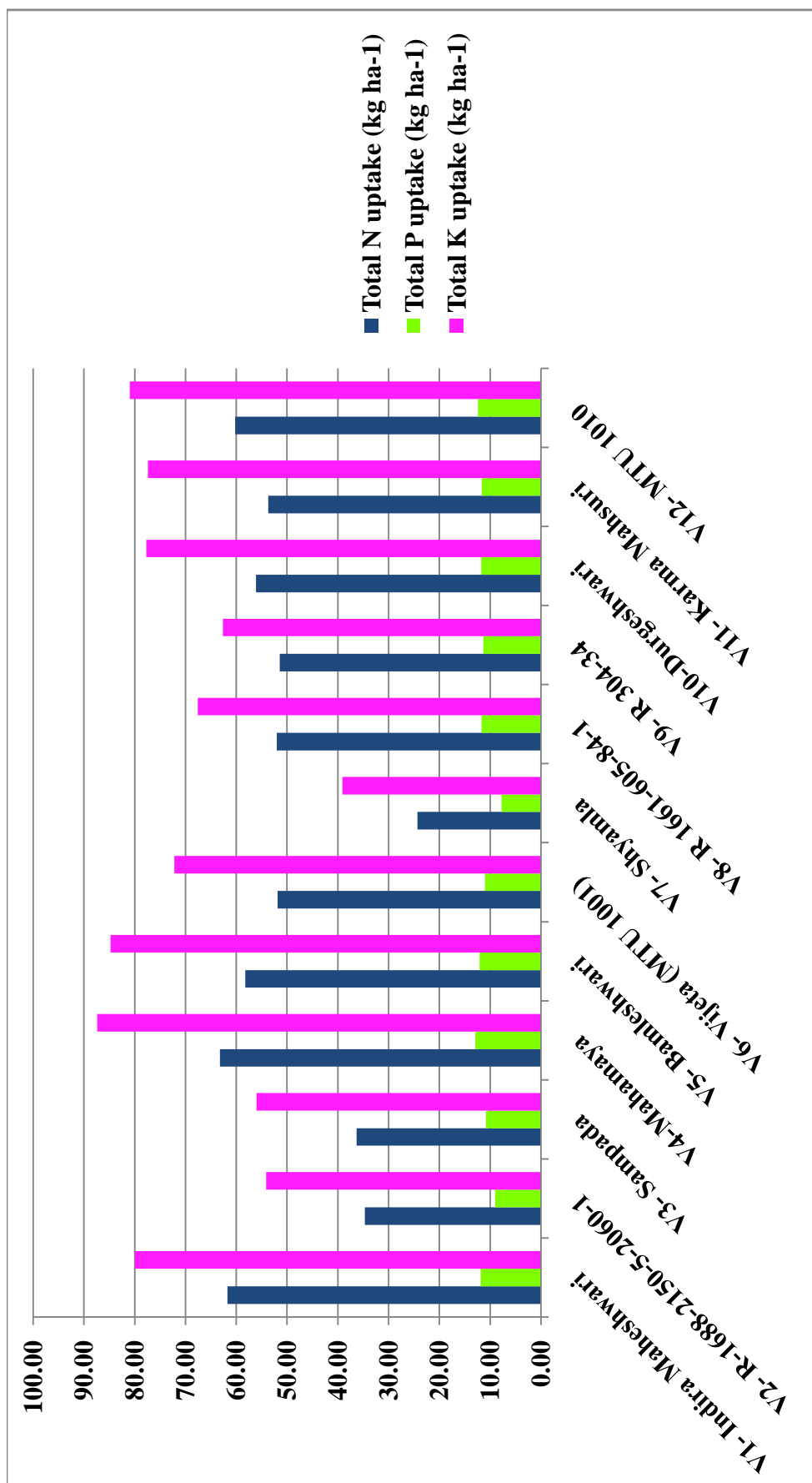


Fig. 4.6 Total N, P K uptake in different rice genotypes in acid soils

4.4.2 Total P uptake

The data presented in Table 4.6 and Fig.4.6 stated that in acidic soils the maximum P uptake was observed in genotype Mahamaya (12.93 kg ha⁻¹) which is significantly superior among all the other genotypes while the second highest P uptake was observed in MTU 1010 followed by Bamleshwari, while the minimum was observed in Shyamla (7.80 kg ha⁻¹).

Data presented in Table 4.7 and Fig. 4.7 showed that the maximum P uptake in neutral soil which was observed in genotype Mahamaya (19.37kg ha⁻¹) which was significantly superior and at par with R 304-34, Bamleshwari and followed by Indira Maheshwari and the lowest P uptake value was recorded in Shyamla (11.69 kg ha⁻¹).

Table 4.7 Total N, P and K uptake in different rice genotypes in neutral soil

Treatments	Total N uptake (kg ha ⁻¹)	Total P uptake (kg ha ⁻¹)	Total K uptake (kg ha ⁻¹)
V1- Indira Maheshwari	86.86	17.82	122.30
V2- R-1688-2150-5-2060-1	64.83	13.30	99.45
V3- Sampada	65.09	14.05	106.14
V4- Mahamaya	89.78	19.37	129.72
V5- Bamleshwari	87.51	18.20	125.44
V6- Vijeta (MTU 1001)	78.11	14.98	97.73
V7- Shyamla	60.61	11.69	91.61
V8- R 1661-605-84-1	68.70	14.23	88.96
V9- R 304-34	89.23	18.75	127.82
V10- IGKVR2 (Durgeshwari)	76.56	14.58	97.09
V11- Karma Mahsuri	63.52	13.06	97.86
V12- MTU 1010	83.70	15.85	121.31
SEm±	0.71	0.48	0.38
CD (P=0.05)	2.11	1.42	1.12

4.4.3 Total K uptake

The data presented in Table 4.6. and Fig. 4.6 stated that in acidic soils the maximum K uptake was observed in genotypes showed that Mahamaya (87.41 kg

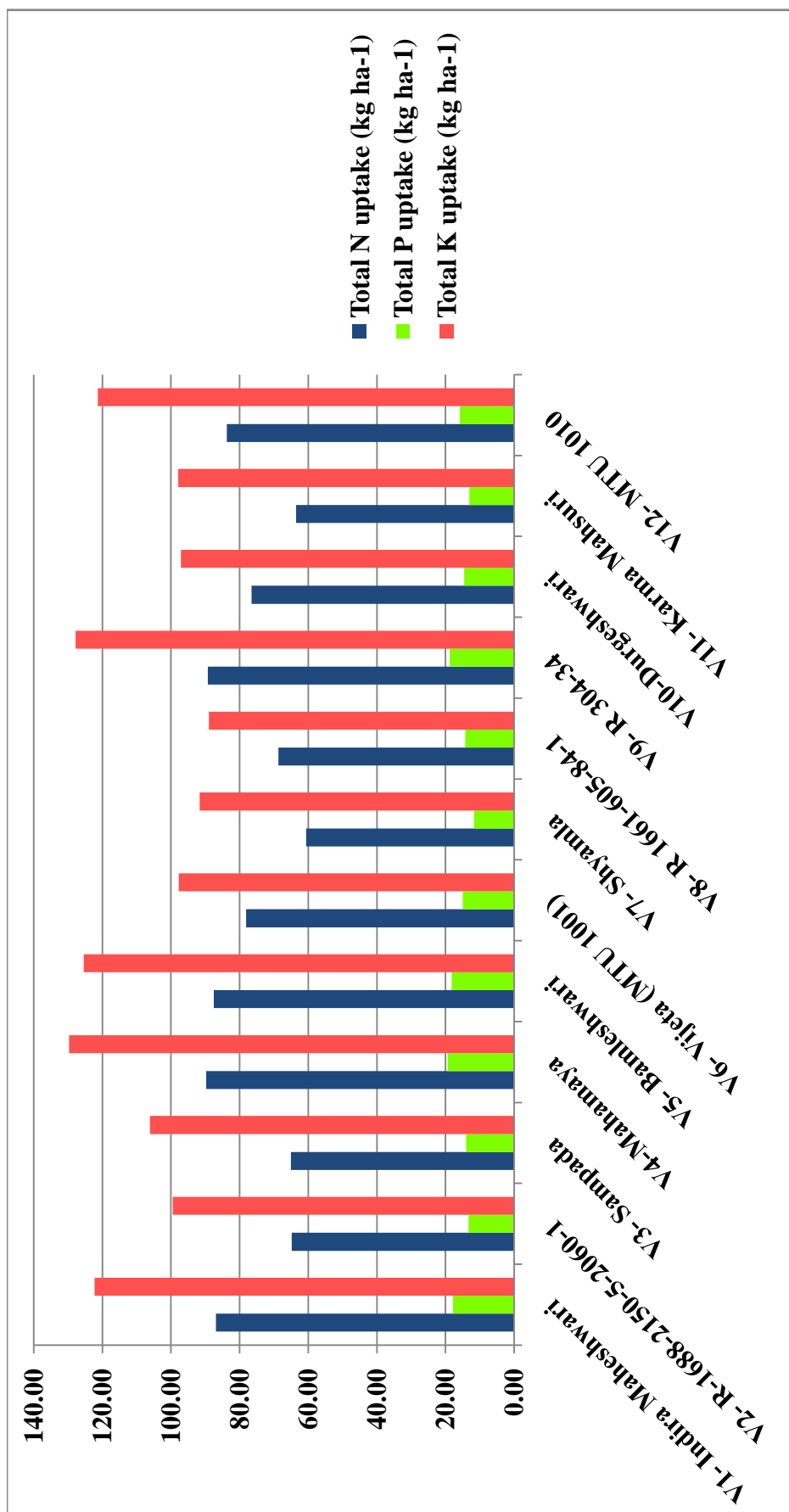


Fig.4.7 Total N P K uptake in different rice genotypes in neutral soils

ha⁻¹) which is significantly superior among all the genotypes whereas the Bamleshwari is the second highest followed by MTU 1010 and Indira Maheshwari and the minimum uptake were seen under Shyamla (39.12 kg ha⁻¹). Data presented in Table 4.7. and Fig. 4.7. stated that K uptake in neutral soil is significantly superior in genotype Mahamaya (129.72 kg ha⁻¹) which was followed by R 304-34, Bamleshwari. Apparently, low K uptake was recorded in R 1661-605-84-1 (88.96 kg ha⁻¹).

The higher uptake by different genotypes of different groups may be due to better root geometry, ability of plants to take up sufficient nutrients from lower or subsoil concentrations, plants ability to solubilize nutrients in the rhizosphere, better transport, distribution and utilization within plants and balanced source-sink relationships. Similar findings also reported by Graham (1984), Baligar *et al.* (2001), Fageria and Barbosa Filho (2001), Fageria and Baligar (2003). The nutrient uptake and utilization are also genetically controlled which vary with crop species and genotypes. Similar findings also reported by Gerloff and Gabelman (1983), Baligar *et al.* (1990), Baligar *et al.* (2001), Epstein and Bloom (2005) and Fageria and Baligar (2005).

Acidity is a problem in its own right, the rice varieties which are not tolerant to soil acidity yielded less may be due to their low nutrients use efficiency and enabling to uptake proper nutrients inadequate amount by genotype. The results regarding inter- and intra-specific plant differences for tolerance to soil acidity have been reported by Foy (1984) and Baligar *et al.* (1987). Similar results of higher accumulation of N and P in grain improve yield of genotype also found by Fageria *et al.* (2006) and Fageria *et al.* (2010).The genotypes grown in highly acidic condition showed intra specific diversity in macro and micro nutrients uptake.

4.5 Soil fertility status after harvest crop in acidic and neutral soils

At the time of harvest the pH of the soil recorded in acidic and neutral soils are 4.6 and 6.7 respectively.

4.5.1 Available soil N status

The data presented in Table 4.8 and Fig. 4.8 revealed the different levels of available nitrogen at harvest of the crop in acidic soil, the highest level of available N was found in treatment MTU 1010 (177.68 kg ha⁻¹) which is significantly at par with following treatments Karma Mahsuri> R 1661-605-84-1> Durgeshwari >Indira Maheshwari>Bamleshwari>Mahamaya>R 304-34>Vijeta and the lowest level of available N is observed in treatment R-1688-2150-5-2060-1 (163.17 kg ha⁻¹).

The result presented in Table 4.9. and Fig. 4.9 on available N in neutral soil revealed that the treatment Vijeta (254.60 kg ha⁻¹) which was significantly at par with following treatments R 1661-605-84-1>Indira Maheshwari> Durgeshwari> Sampada> Karma Mahsuri>Shyamla and the lowest level of available N was observed in treatment Mahamaya (246.80 kg ha⁻¹).

4.5.2 Available soil P status

The data presented on Table 4.8 Fig.4.8 revealed that available P at harvest in acidic soil was maximum in Durgeshwari (10.34 kg ha⁻¹) which was significantly superior and at par with Vijeta> Bamleshwari>Shyamla>Indira Maheshwari>Mahamaya>Sampada>MTU 1010 and the minimum level of available P was observed in R-1688-2150-5-2060-1 (9.61 kg ha⁻¹).whereas in neutral soil Table 4.9. and Fig. 4.9 available P was found maximum in Shyamla (14.61 kg ha⁻¹) which was significantly superior and at par with R-1688-2150-5-2060-1> R 1661-605-84-1> Mahamaya> Sampada> Indira Maheshwari> Bamleshwari and the minimum level of available P was observed in R-304-34 (14.19 kg ha⁻¹).

Table: 4.8 Status of macronutrients in soil at harvest in acidic soils

Treatments	Available Nitrogen (kg ha⁻¹)	Available phosphorus (kg ha⁻¹)	Available potassium (kg ha⁻¹)
V1- Indira Maheshwari	175.48	10.10	151.02
V2- R-1688-2150-5-2060-1	163.17	9.61	152.91
V3- Sampada	170.59	10.01	155.15
V4- Mahamaya	173.79	10.06	158.52
V5- Bamleshwari	173.85	10.13	153.94
V6- Vijeta (MTU 1001)	171.32	10.24	148.95
V7- Shyamla	167.89	10.16	151.27
V8- R 1661-605-84-1	176.40	9.92	155.06
V9- R 304-34	171.90	9.84	155.78
V10- IGKVR2 (Durgeshwari)	176.09	10.34	153.42
V11- Karma Mahsuri	176.76	9.71	153.84
V12- MTU 1010	177.68	9.95	152.86
SEm±	2.59	0.13	1.61
CD (P=0.05)	7.59	0.40	4.73

4.5.3 Available soil K status

The soil available K status in acid soil (Table 4.8 and Fig.4.8) was found maximum in Mahamaya (158.52 kg ha⁻¹) which was significantly superior and at par with R-304-34>Sampada> R 1661-605-84-1>Bamleshwari>Karma Mahsuri and the minimum level of available K was observed in Vijeta (148.95 kg ha⁻¹).

Whereas, in neutral soil (Table 4.9. and Fig. 4.9.) stated that in neutral soil condition available K was found maximum in Durgeshwari (329.70 kg ha⁻¹) which was significantly superior and at par with Sampada>Shyamla>Karma Mahsuri> R-1688-2150-5-2060-1>R-304-34>MTU 1010 and the minimum level of available K was observed in Mahamaya (323.93 kg ha⁻¹).

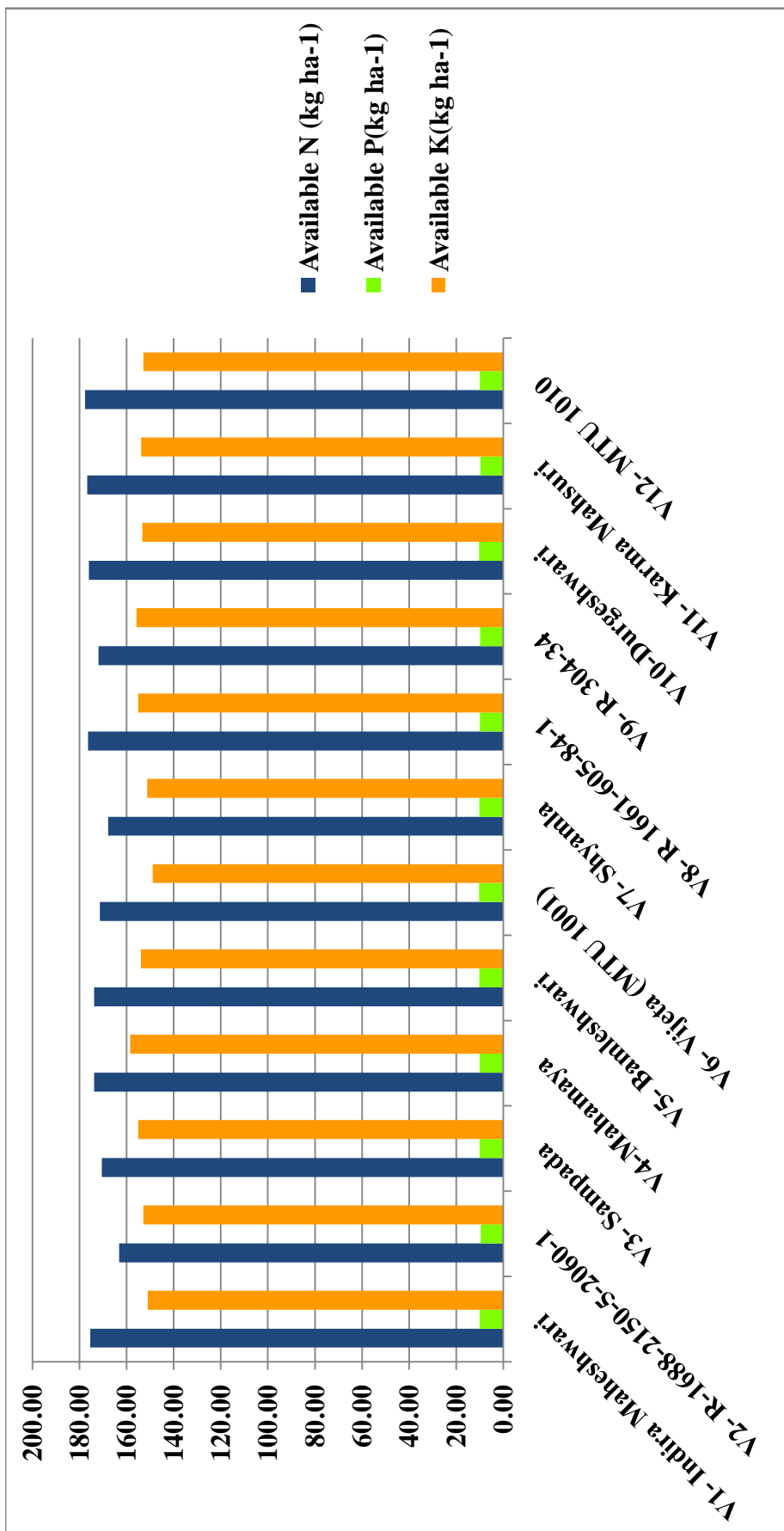


Fig.4.8 Status of macronutrients in soil at harvest in acidic soils

Table: 4.9 Status of macronutrients in soil at harvest in neutral soils

Treatments	Available Nitrogen (kg ha⁻¹)	Available phosphorus (kg ha⁻¹)	Available potassium (kg ha⁻¹)
V1- Indira Maheshwari	253.56	14.47	324.97
V2- R-1688-2150-5-2060-1	250.21	14.58	327.64
V3- Sampada	252.59	14.49	328.22
V4- Mahamaya	246.80	14.51	323.93
V5- Bamleshwari	249.12	14.46	325.76
V6- Vijeta (MTU 1001)	254.60	14.32	325.07
V7- Shyamla	251.69	14.61	328.07
V8- R 1661-605-84-1	254.39	14.53	324.53
V9- R 304-34	249.36	14.19	327.39
V10- IGKVR2 (Durgeshwari)	253.46	14.42	329.70
V11- Karma Mahsuri	252.44	14.45	327.79
V12- MTU 1010	249.77	14.41	326.44
SEm±	1.10	0.05	1.12
CD (P=0.05)	3.24	0.15	3.28

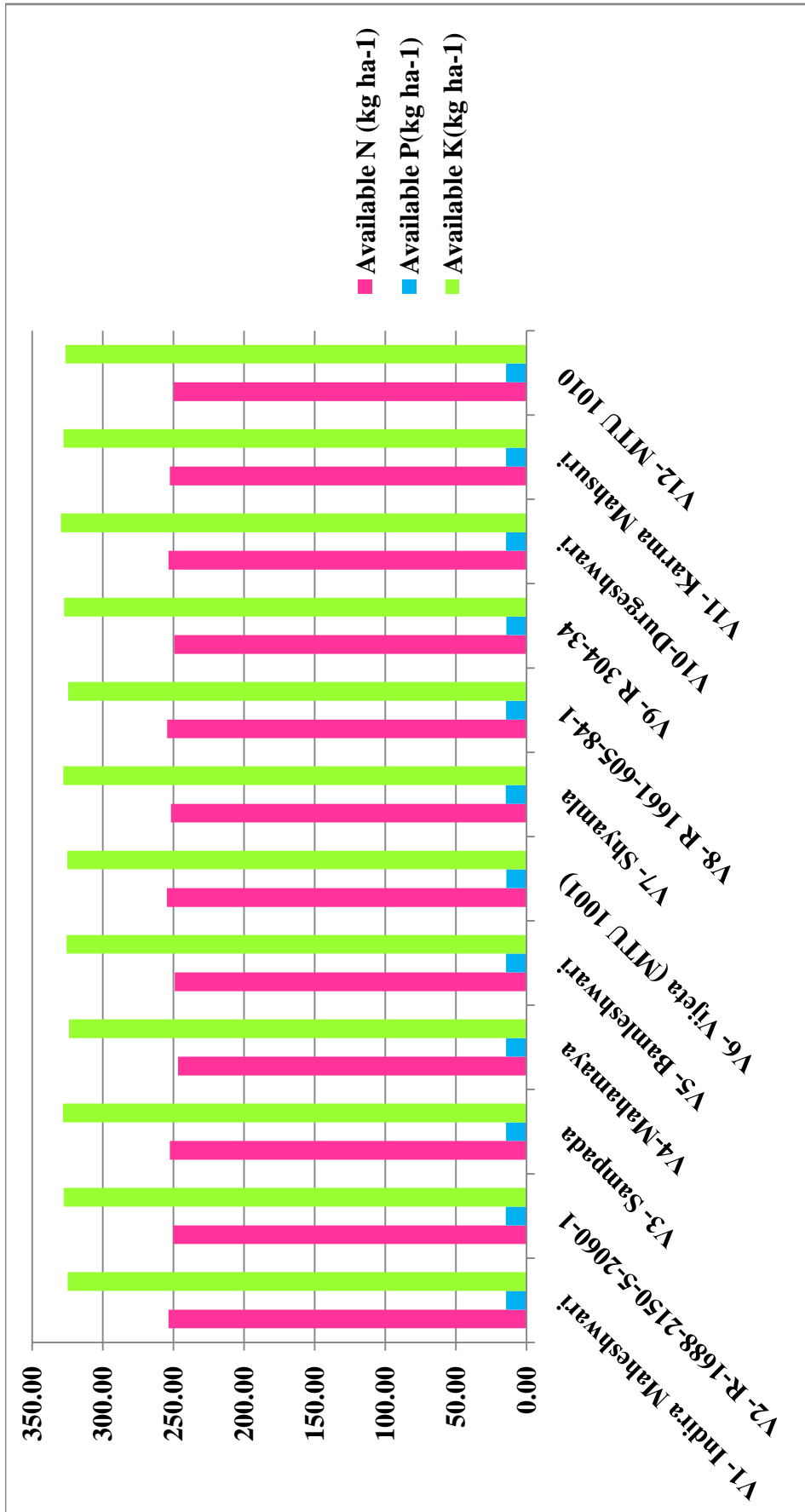


Fig.4.9 Status of macronutrients in soil at harvest in neutral soils

CHAPTER-V

SUMMARY AND CONCLUSIONS

The present investigations entitled “Evaluation of rice genotypes in acidic and neutral soils of northern hills of Chhattisgarh” were carried out at the farmers field of village Ajirma and Research Farm of RMDCARS Ambikapur (C.G.) in Kharif (2014).

With the (a) To study the performance of different rice genotypes under neutral and acidic soil conditions. (b) To estimate the nutrients uptake by rice genotypes in both the soil conditions. (c) To assess the fertility status of the soil.

The experiments were undertaken with twelve treatment and two field conditions acidic and neutral was laid in randomized block design. Treatments consisted of V1 (Indira Maheshwari), V2 (R- 1688-2150-5-2060-1), V3 (Sampada), V4 (Mahamaya), V5 (Bamleshwari), V6 (Vijeta), V7 (Shyamla), V8 (R 1661-605-84-1), V9 (R 304-34), V10 (Durgeshwari), V11 (Karma Mahsuri) and V12 (MTU 1010) followed under optimum agronomic management practices.

Keeping in view the objectives, observation and the results were recorded, processed statistically on various parameters for scientific interpretation.

The yield of paddy grain and straw was affected significantly due to two different soil conditions Among the tested genotypes in acidic soil condition Mahamaya, Bamleshwari, MTU 1010 and Indira Maheshwari gave significantly higher yield *i.e.*, 39.35, 38.23, 37.83 and 36.96 q ha⁻¹ respectively which was found superior over remaining genotypes. While, the lowest yield was given by Shyamla 16.81 q ha⁻¹.

Similarly, in neutral soil Mahamaya was found significantly superior in respect to yield followed by R 304-34 , Bamleshwari and Indira Maheshwari which gave grain yield 59.64, 57.28, 55.79 and 53.78 q ha⁻¹ respectively, while the lowest yield was recorded in neutral soil in two genotypes *i.e.*, Karma Mahsuri 38.12 and Shyamla 32.17 q ha⁻¹. The highest total NPK uptake was shown by

Mahamaya in both the soils, the lowest yield loss due to acidity was recorded in genotype V11(Karma Mahsuri) (13.32%) whereas highest yield loss percentage was observed in genotype R 304-34 (52.58%), although R-304-34 was second high yielder (57.28 q ha⁻¹) in neutral soil but performance in acidic soil was comparatively low (27.16 q ha⁻¹).

Conclusion

- The various genotypes grown in acid and neutral soils differ significantly in growth, grain yield, and yield components.
- The genotype Mahamaya shows the higher yield with respect to that it also shows maximum no. of effective tillers hill⁻¹, filled grains panicle⁻¹ and highest test weight and comparatively, high total N P K uptake so it is cleared that among the genotypes most of the growth and yield components shows the positive association with grain yield.
- Conclusively it can be stated that the genotypes of higher yield potential with efficient nutrient use ability can be useful to breeding programme for developing new lines which can tolerate the high soil acidity with greater adaptability.

Suggestions for future work

Further research on present investigation is needed to evaluate the performance of improved genotypes which can withstand with acid stress conditions under different agro-climatic condition to have sound recommendations of genotypes for acid soil condition. The best genotypes of rice can be used in the breeding programme to get the suitable acid tolerant genotypes.

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Appendix A: Weekly meteorological data during crop growth period (06 July to 18 Nov.2014)

Week No.	Date	Max. Temp.	Min. Temp.	Rain Fall (mm)	Relative Humidity I (%)	Relative Humidity II (%)	Wind Velocity (Kmph)	Sun Shine(hours)	Evapo-ration (mm)	Rainy Days
32	Aug 06-12	26.5	21.1	163.6	96.7	90.3	5.5	2.2	3.2	5
33	13-19	29.6	22.0	36.2	96.0	70.0	3.4	4.0	3.5	1
34	20-26	31.9	22.5	0.0	94.7	61.7	3.0	5.1	5.0	0
35	27-02	29.8	21.4	39.0	95.0	72.3	3.0	5.3	3.6	5
36	Sep 03-09	27.9	21.6	56.4	94.7	78.6	3.9	3.0	3.3	3
37	Sep 10-16	29.4	22.0	22.4	94.9	69.3	2.6	4.0	2.9	3
38	17-23	29.8	21.1	27.0	92.7	72.1	2.1	5.5	3.8	2
39	24-30	31.8	19.2	0.0	90.7	51.4	2.2	8.2	4.4	0
40	Oct 01-07	30.2	18.5	0.0	87.3	64.3	1.8	9.0	4.0	0
41	Oct 08-14	28.7	18.9	42.7	92.6	84.4	4.2	4.1	3.9	4
42	15-21	29.3	16.3	0.0	94.1	53.5	1.5	7.7	3.8	0
43	22-28	27.4	13.9	0.0	92.0	55.1	1.6	6.0	3.9	0
44	29-04	28.6	12.0	0.0	89.4	37.6	1.6	8.5	4.1	0
45	Nov 05-11	28.5	11.1	0.0	90.7	37.0	1.5	7.8	4.1	0
46	Nov 12-18	28.1	10.7	0.0	85.6	31.4	1.6	8.4	3.9	0

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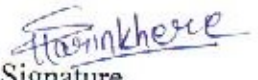
Degree	Year	University/Institute
1. Higher Secondary	2009	CGBSE, Raipur
2. B. Sc. (Ag.)	2013	IGKV, Raipur
3. M. Sc. (Ag.)	2015	IGKV, Raipur

Professional Experience : RAWE (6 months)

Membership of Professional Societies: Nil

Awards / Recognitions: Nil

Publications: Nil


Signature