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JUTE DIVERSIFIED PRODUCTS: ASPECTS AND PROSPECTS

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Jute and allied fibre crops play a significant role in the country's economy. Considering its national importance, jute was regarded as "golden fibre". With the inroads of synthetics and stiff competition from other countries the crop had to face critical problems mainly from the seventies. Considering the global awareness relating to environmental pollution, the crop is again receiving its importance. Jute being a cheap annually renewable source of raw materials and considering its environment friendliness, it has greater advantage over the costly plant species used for the same purpose particularly the textiles and paper industries. People are now getting more concerned about the environment pollution and prefer to use natural products instead of man made synthetic products which are not degradable. While Jute and allied fibre crops are not only biodegradable but also eco-friendly. Consequently diversification of various types of jute and jute based products have brought about a new dimension in the changing scenario in the jute and allied fibre sector.

Jute, mesta, sunhemp and other fibre crops naturalized for thousands of years in Indian sub continent, do not require heavy investment unlike many other field crops in terms of irrigation water, fertilizers and pesticide use, yet substantial amount of high cellulose biomass per unit land area is produced. These agricultural commodities are very cost effective raw materials for bulk consumption in appropriate industries. The major constraint in their extensive industrial use is that most of them are annuals and unless proper strong arrangements are made year long supply of raw materials might be a problem. In addition, as a fibre this has to compete with man made fibre in its cost effectiveness and utility.

Jute is grown in about 8-8.5 lakh ha and 2-2.5 lakh ha are under allied fibres. Jute together with other allied fibres give about 115 lakh bales (180 kg each). About 70% jute area is in the State of West Bengal.

The commendable research efforts by jute research organizations resulted in improvement in fibre quality, improved methods of fibre extraction, improved technical processing of fibre and finally, identification of value–added application areas of jute fibre. But these potential areas of applications virtually remained to be exploited for long, partly because of disorganized linkage between research organizations and industries, which were compounded by the luke warm response from big players of the jute industrial sector. This is because jute industry is a very old and established industry, compact and labour-intensive in nature, and run by seasoned manner. Faced with financial crisis, adverse marketing conditions and other factors, jute industry remained conservative for long to combat the situation as it arose.

We are not certain when the phenomenon of jute diversification emerged in India but certainly the spurt in product diversification research began in the eighties. This is also the time when jute started facing stiffer challenges from the man-made fibre. It was a necessity: an exigency to bale out jute from the crisis.

Fortunately, the post 1990 era witnessed a perceptible shift in understanding the prospects and potential of jute because policy makers were by then convinced. It was at this stage the National Centre for Jute Diversification (NCJD) and 'Jute Manufacturers

Development Council' (JMDC) came in a big way to drive home the importance of product diversification. Directions for action were set at the highest level. Assistance to the decentralized sector took off. Raw materials supply to these sectors and marketing of diversified products started to flow, although in a limited scale.

A brief overview may be interesting to note. In 1995, there were about 500 units engaged in jute diversification work. These units were located close to jute growing areas only and their product mix, standard of finish and production capacity were barely sufficient to cover local/ domestic requirements. With the passing of years and the implementation of various promotional schemes by NCJD, considerable advancement has been attained in jute diversification both geographically as well as in the range of products. By 1997, nearly 700 and during the last three years approximately another 300 units have been added in various jute diversified activities. NCJD, through its JEA Scheme and NGO Scheme, added another nearly 300 units during the period. The Raw Material Bank itself (being one of the sources of raw material supply) has distributed an average of over 1,200 metric tones of yarn and about 5,00,000 metres of fabric each year during the last six years. It has been assessed that after the close of the last plan period a lakh metric tones of raw jute is under consumption annually engaging nearly 25,000 individuals directly and indirectly in jute diversification.

Due to the continuous support by the Indian government towards jute diversification, the use of jute is increasing rapidly in new diverse areas such as paper, paper boards, composites, roofing sheets, egg trays and made up items. Also, finer yarns were spun for use of jute in garments, quality handloom, mixing in woven products like apparel, wrappers, floor coverings, etc. Items of regular and mass consumption like shopping bags, soft luggage, accessories, etc. are being manufactured extensively and in almost all parts of the country. Through the Design Development Scheme of NCJD newer designs based on trend and fashion are continuously being fed to the beneficiaries to meet the market demand. Further, promotion of the chemical processing mechanism of jute has now been put into extensive use in handloom, handicraft and various other woven products under the small unit segment. The Centre has also developed low-cost jute carry bags for providing to the market an alternative to plastic carry bags. These and various other such products have received very encouraging response from the markets across the country. NCJD assistance has also permeated considerably into the non-jute growing areas of Himachal Pradesh, Uttaranchal, Jammu & Kashmir, Punjab, Haryana, Rajasthan, Gujarat, Karnataka, Tamil Nadu and Maharashtra.

JMDC undertakes on regular basis the following activities:

Development of domestic market
Development of Export market
Facilitatory activities

As a result, the exports of jute diversified products (JDP) have increased from Rs. 64 crores in 1997-98 to Rs. 135 crores in 2001-02; an increase from 9% to 22%. Keeping this trend in view, the projected overall demand for jute fibre during 2008-09 would be around 170 lakh bales as against 115 lakh bales for 2002-03. In 1999-2000, five major importers of Indian JDP were: USA (34%), Germany (9%), U.K. (7%), Belgium (5%), Italy (5%) and others (40%).

It is well known that better fibre quality particularly fine fibre is the basic pre-requisite for various diversified products. Accordingly, the gap between supply and demand for better fibre quality is ever increasing.

Being well aware of this necessity, Central Research Institute for Jute and allied Fibres (CRIJAF) released cv. JRC-321 of white jute long back, which has the finest fibre till date measuring 9 denier at carding while that of tossa jute variety ranged between 15-20 denier (cotton fibre 5 denier). Still finer fibre is needed for blending with other fibers to produce light weight fabrics. In accordance, CRIJAF has top priority to:

- Inherent biological manipulations to improve per se fibre fineness with adequate strength and fibre strength, in general.
- Imparting high cellulose and low lignin content in fibre, which are determinants of good fibre quality, by QTL based breeding for optimum lignin.
- Identification of resource materials from the existing gene pool and involving in breeding programme for quality improvement.
- Molecular characterization of traits controlling fibre quality to undertake marker-assisted breeding.
- Development of mechanized low cost ribboner, which would help in getting quality fibre in short duration.
- Popularizing ramie, the best quality bast fibre, in non-traditional areas.
- A fresh look on flax-linen yarns, an all time classic, for its unique properties and adaptability to different spinning system.
- Jute / sisal and jute/ sunnhemp blends for improving complimentary quality parameters.
- Development of farmers-friendly retting methods and *ascertaining* agricultural determinants to improve fibre quality.
- Standardization of farmer's- friendly deguming method in ramie.

Silver lining for the jute industry is the fact that Government of India highlights the importance of natural fibres during WTO negotiations. The government is lobbying hard against an allegedly 'skewed' policy of charging variable applied tariffs for goods in developed and developing countries. Industry experts point out that applied tariffs in developed countries for other proposed goods are already very low at 2-5%. While Indian applied tariffs are in the range of 25%. While applied tariffs are quite low for raw materials in major developed countries, they range between 0-20% for made ups and value-added products. So, a reduction in import tariffs for these products would be beneficial for India.

These efforts and developments, indeed, have made a new beginning but not sufficient in the total perspective. The challenges ahead are many. In a bigger scale, unless the major players of jute sector are involved in the diversification phenomenon, the mission will be far from complete. The jute industry would notice that things are changing in every sphere, seasoned managers are also expected to change concomitantly, otherwise they will shrink and stagnate in no time. Let us look where they may play their role as catalyst for product diversification.

Packing segment

Packaging has been the mainstay of jute and may continue to be so. But the conventional A-twill/B-twill packaging is likely to undergo changes due to the ILO (International labour organization) norms on manual handling of commodities and packages (i.e. 55/50 kg). If a jute bag has to carry only 50 kg (as against 95/100kg), then the conventional size and structure of jute bag is not cost effective. There is need for redesigning the fabric and the bag to suit the new ILO norms. Attempts should be made to reduce the cost of these bags. Even if the market for jute bags does not expand, the fact that 50 kg bags will be used in preference to 95/100 kg bags should increase the demand for the number of bags thereby increasing, though marginally, the demand for jute. However, there is apprehension that this segment may be taken over by synthetics. With implementation of strict environmental norms and with the production of hassian fabrics with vastly improved texture, colour and considerably reduced weight per unit area and hairiness, the export market can be enhanced.

In the segment of bags for shopping and similar other uses, there is a visible preference by the consumers for jute /paper bags as against plastic bags in many markets. If this, consumer preference has to be converted in favours of jute, better fabric, better bleaching/printing and more aesthetic designs have to be put in the market at competitive prices. It may be worthwhile to attempt for a paper-jute combination bag also. Apart from product design and product engineering, consumer preferences and packaging requirements of various commodities and products have to be considered while designing/manufacturing these bags for specific markets. Codification of standards and specifications of jute based products must facilitate quality assurance.

TECHNICAL TEXTILES

Technical textiles have a very large market in the world. The main feature of technical textiles is that aesthetics do not form any worthwhile part of technical textile applications. Technical textiles are rated on specific performance parameters. The "negative" (?) image of jute as a hard and unattractive fibre does not affect its performance in technical textiles. However, product specifications for various applications need to be finalized in consultation with the end-users to ensure structural soundness.

With minor additions/modifications to conventional jute processing machinery, fabrics for geo textiles (in addition to the conventional soil savers) can be manufactured. The demand for geo-textiles is increasing in various parts of the world. However, absence of adequate awareness and accepted standards and specifications seem to be affecting the possible expansion of the market. While construction engineers have to be convinced of the advantage of using jute as geo-textiles, the industry also needs to take initiatives in evolving product descriptions and finalizing specifications for geo-textiles for various uses like irrigation, sol conservation, rural roads, bridges, etc.

PULP AND PAPER

The demand for pulp and paper is increasing and is expected to grow. Concerns of environmental degradation and sustainable development have forced many countries to explore the options of recycling paper and experimenting with non-wood sources for making pulp. Jute sticks have been found to be an excellent raw material for making pulp and paper. However, there seems to be reluctance on the cost of investment and due to availability of soft wood at the present level of prices. The situation may undergo a change when forest resources start dwindling further. While the technology for making pulp and paper from whole jute/kenaf exists, modifications are being attempted to make the process more economical. Once the commercial viability improves further, whole jute/kenaf could become a major source for pulp and paper.

JUTE PARTICLE BOARD

The use of wood in house construction, furniture, etc. is slowly being discouraged due to environmental reasons. The use of jute particle board as a substitute has been found to be quite acceptable both in terms of quality and price. This is a fast expanding segment in the market. Attractive jute particle boards are being made mainly at small scale level at present. What is needed is product development, a thrust on marketing and economics of scale.

JUTE FLOOR COVERINGS

From the conventional carpet backing cloth, jute has moved up the value chain and is being used to make attractive floor coverings. Consumer preference is also shifting away from synthetics to natural floor coverings. Attractive jute woven carpets have found a niche in market. Given proper attention to consumer preferences, improvement in dyeing and processing and market development, this segment can grow.

THERMOSETTING COMPOSITES

Jute thermosetting composites using jute hessian cloth and thermosetting resin have been found to be very useful for making furniture, building materials (like window and door frames, corrugated sheets for roof), parts in motor vehicles and railway wagons. These products are fire retardant, unbreakable, UV and water-resistant, termite, acid and alkali resistant, and have low thermal conductivity. It is also eco-friendly and cost-effective. With the phasing out of asbestos, jut composites can make a bigger impact in the market. In this segment also, more innovative designs and improvement in product specifications are required.

NON- WOVEN PRODUCTS

Jute non-woven products have been introduced in the automobile and foot wear industries. These could also be used as insulation material thereby reducing the need to use non-biodegradable materials like glass fibre. These applications, however, require a higher degree of development, standardization and processing.

HOME TEXTILES

With cotton fabrics moving up the price ladder and the value chain, jute can replace cotton fabrics either by itself or as a blend with cotton for home textile applications. Attractive fabrics for use as upholstery and tapestry have already been developed and are in the market. Jute blankets made out of pure jute or jute and wool have the advantage of providing the necessary thermal protection particularly to the poorer people at much lower costs. There is scope for increasing the size of the market.

HANDICRAFTS

A variety of handicraft items are being produced from jute fabric and jute yarn by a large number of poor people particularly women in jute producing countries. These products vary from cushion covers to lampshades, from hats to foot wear, and from hand bags to fashion accessories. Considering the value addition and the employment such handicrafts provide, this segment can grow significantly provided market and design support are provided.

NEW AREAS FOR GROWTH

To achieve significant growth, jute needs to get into large volume applications quickly. Some of the areas, which can be considered are garbage disposal bags from jute fabrics, nursery plant tubes from jute fabrics and other technical textile applications. These would require development of products particularly taking consumer preferences into account. This also needs concerted efforts in marketing. If these ideas could succeed, jute could replace many other fibres and become the most versatile fibre in the global market.

Jute caddy is a reliable renewable energy source. Jute caddy based captive power plant for the jute mills would appreciably bring down the power cost of the mill. Last but not the least, the most important aspect we have overlooked till date are important secondary metabolites these group of crops produce in their life cycle. It has been brought to our notice that jute and allied fibre crops produce several pharmaco-dynamic compounds, which may be harnessed as plant-based pharmaceuticals, an upswing trend world over for several reasons. Sisal leaves have good amount of quality wax with high melting point, which may be used in various industrial appliances. Sunnhemp seed protein may be used in plywood industrials as adhesive. Roselle (H.S. Mesta) seed oil would be edible, if properly treated. There are other chemicals, which may be used in various applications like toiletries, chemicals for food products, etc. We need to have an innovative mindset to unearth hidden potentials.

In the backdrop of these immense potentials, it is clear that situation will no longer remain unchanged. The industry would require to change its long term objectives, plan and action. Only then the era of diversification programme will gain momentum.

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RESPONSE OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) TO NITROGEN LEVELS AND ITS MANAGEMENT ON GROWTH, YIELD AND OIL CONTENT

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ABSTRACT

A field experiment was conducted during the winter seasons of 1996 and 1997 to study the response of sunflower to levels of nitrogen and its management on growth, yield and oil content. The growth parameters viz., plant height, stem girth, LAI and DMA were increased significantly with increasing levels of nitrogen and its management methods. Application of 120 kg N ha^{-1} produced maximum growth character than rest of the levels. The protein content also increased with successive levels of nitrogen but oil content inversely responded with the higher levels of nitrogen beyond 80 kg N ha^{-1}. The yield attributes like head diameter, seeds head^{-1}, test weight, grain and stover yields were increased with each successive levels of N and were maximum under 120 kg N ha^{-1}. Among nitrogen management practices the application of N as 65% basal + 35% at 45 DAS through NCU, influenced the growth and yield significantly over full basal application. However, the application of nitrogen through prilled urea as 50% basal+25% at 45 DAS + 25% at 65 DAS produced at par growth and yield attributes of sunflower.

INTRODUCTION

India is the largest oilseed growing country with 20 % of world's oilseed area, but third in oilseed production due to inferior productivity (700 kg ha^{-1}). However, the oilseed scenario in the country has undergone a drastic change in the recent years. The import of edible oil have come down sharply, whereas, the export of oilseed extracts have registered a quantum jump, placing the oilseed sector in a respective position in Indian foreign exchange economy.

Out of the different edible oilseed crops, sunflower contributes approximately 8-10% of total oilseed production in India. Sunflower oil is rich in poly unsaturated fatty acids, pleasant flavour with excellent keeping quality, its demand as edible oils is increasing. The sunflower oil contains 45-50% collesterol free oil and high quality protein (16-18%) and rich in lenoleic acid (62.5%) for which it is recommended as a dietary constituent to the heart patients. The sunflower plant being not choicy for soil and climate as other oilseed crops are, its acreage is increasing gradually. The wide adoptility by farmers because of its desirable attributes like, low seed rate, high multiplication ratio (1:100), short duration, photo insensitiveness, high water and fertilizer responding and high oil content of healthy quality. It can be substituted with other oilseeds and well fitted in multiple cropping system.

Generally, sunflower is grown in marginal soil with poor crop husbandry under mostly rainfed or partial irrigated conditions. This may be the major constraints for its low productivity. However, recent researches have claimed its higher productivity with hybrid and improved production technologies. Advancement in nitrogen levels, with split application and inhibiting nitrification by blending of urea with coating nitrogen use efficiencies but also positively responded in production and quality of sunflower oil (Khan, 1996). Keeping this in mind the present investigation was undertaken to find out suitable dose, time and method of nitrogen management and effects of nitrification inhibitor on growth yield and quality of sunflower.

Table 1: Effect of levels of nitrogen and its management on growth attributes, nitrogen protein and oil content of sunflower.

Treatment	Plant height (cm)		Stem girth At harvest (cm)		LAI at harvest		DMA (g) 30DAS		N content in seeds (%)		Protein content (%)		Oil content (%)	
Nitrogen levels	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
40 kg ha^{-1}	1.18	1.19	1.91	1.93	1.70	1.72	41.8	43.4	2.66	2.68	16.6	16.7	37.2	38.0
60 kg ha^{-1}	1.29	1.31	2.11	2.12	1.83	1.85	48.4	50.5	2.76	2.77	17.2	17.3	39.8	40.7
80 kg ha^{-1}	1.33	1.36	2.19	2.22	2.01	2.02	55.8	57.1	2.85	2.86	17.8	17.8	42.3	43.5
100 kg ha^{-1}	1.38	1.40	2.23	2.24	2.22	2.24	61.3	64.6	2.97	3.01	18.6	18.8	38.4	39.6
120 kg ha^{-1}	1.41	1.43	2.25	2.27	2.25	2.27	70.2	73.3	3.02	3.04	18.8	19.0	37.9	39.0
SEm ±	0.4	0.03	0.06	0.05	0.01	0.01	1.8	1.6	0.03	0.04	-	-	-	-
CD (P=0.05)	0.13	0.11	0.18	0.16	0.04	0.05	6.0	5.1	0.10	0.13	-	-	-	-
Nitrogen management methods (N)														
50% Basal+50% at 45 DAS (PU)	1.24	1.25	2.10	2.12	1.92	1.94	53.8	54.3	2.84	2.82	17.7	17.6	36.7	39.8
50% Basal+25% at 45 DAS+25% at 65 DAS (PU)	1.29	1.30	2.14	2.17	1.98	2.02	55.3	56.8	2.84	2.84	17.7	17.7	38.6	39.5
100 % Basal (NCU)	1.20	1.23	2.05	2.06	1.80	1.83	46.8	49.7	2.76	2.77	17.2	17.3	39.0	40.2
65% Basal+ 35% at 45 DAS (NCU)	1.33	1.35	2.17	2.19	2.10	2.14	61.2	63.3	2.87	2.88	17.9	18.0	42.2	41.1
SEm ±	0.01	0.01	0.02	0.02	0.02	0.02	1.3	1.6	0.03	0.03	-	-	-	-
CD (P=0.05)	0.04	0.05	0.08	0.09	0.06	0.07	4.1	5.3	0.10	0.10	-	-	-	-

* PU : Prilled Urea * NCU : Nimin Coated Urea

Table 2: Effect of levels of nitrogen and its management on yield attributes of sunflower.

Treatment	Head Diameter (cm)		Number of seeds head $^{-1}$		100 seed weight (g)		Grain yield (t ha^{-1})		Stover yield (t ha^{-1})	
Nitrogen levels (N)	**1996**	**1997**	**1996**	**1997**	**1996**	**1997**	**1996**	**1997**	**1996**	**1997**
40 kg ha^{-1}	10.3	10.3	533	541	4.11	4.13	1.245	1.256	2.763	2.771
60 kg ha^{-1}	10.8	10.6	579	582	4.14	4.15	1.583	1.591	2.948	3.021
80 kg ha^{-1}	11.9	12.1	934	641	4.56	4.56	1.627	1.643	3.260	3.313
100 kg ha^{-1}	12.8	12.9	694	710	4.58	4.69	1.684	1.711	3.485	3.521
120 kg ha^{-1}	13.6	13.7	736	740	4.91	4.95	1.746	1.754	3.647	3.677
SEm $\pm$	0.26	0.25	5.2	5.4	0.12	0.11	0.096	0.095	0.181	0.183
CD (P=0.05)	0.80	0.78	17.1	16.5	0.38	0.35	0.290	0.281	0.557	0.568
Nitrogen management methods (N)										
50% Basal+50% at 45 DAS (PU)	12.6	12.7	666	672	4.72	4.75	1.640	1.674	3.190	3.211
50% Basal+25% at 45 DAS+25% at 65 DAS (PU)	12.8	12.9	671	679	4.77	4.79	1.683	1.691	3.374	3.397
100 % Basal (NCU)	11.5	11.6	647	653	4.21	4.20	1.528	1.588	2.987	3.033
65% Basal+ 35% at 45 DAS (NCU)	12.9	13.2	682	696	4.92	4.94	1.751	1.762	3.492	3.516
SEm $\pm$	0.19	0.20	611	0.03	0.13	0.12	0.059	0.056	0.152	0.130
CD (P=0.05)	0.58	0.62	19.07	18.16	0.41	0.38	0.182	0.174	0.473	0.405

* PU : Prilled Urea * NCU: Nimin Coated Urea

MATERIALS AND METHODS

An experiment was conducted at Research Farm of IGAU, Raipur (C.G.) during winter seasons of 1996 and 1997 under split plot design with three replications. Main plots consisted of five levels of nitrogen (40,60,80,100 and 120 kg N ha^{-1}) while, four methods of nitrogen management viz., 50% N as basal + 50% N at 45 DAS through prilled urea (PU), 50% N as basal +25% N at 45 DAS +25% N at 65 DAS through PU, 100 % N basal through NCU (Nimin Coated Urea), 65% N basal +35% N at 45 DAS through NCU consisted the sub plot treatments. The experimental soil was silty in texture with pH 7.1 and was available N,P and K of 210.3, 18.4 and 325 kg ha^{-1}, respectively. The nitrification inhibitor (Nimin) was used as coating material @ 10 g kg^{-1} urea. A uniform doze of 50 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied as basal. The sunflower cv. Morden was sown with a spacing of 45 cm x 20cm and seed rate of 10 kg ha^{-1}. The crop was sown on 18^{th} Nov. 1996 and 23^{rd} Nov. 1997 and harvested on 28^{th} March 1997 and 5^{th} April 1998, respectively.

RESULTS AND DISCUSSION

The increasing levels of nitrogen significantly increased the growth parameters. The plant height, stem girth, LAI and DMA were increased significantly upto 100 kg N ha^{-1}. However, it was at par with 120 kg N ha^{-1}. lowest growth parameters were recorded under lower levels of nitrogen. The split application of NCO (65% N as basal+35% N at 45 DAS) was registered significantly superior over rest of the nitrogen management practices. However, application of 50% N as basal+25% N at 65 DAS through PU also produced comparable growth parameters over application of 100% N as basal through NCU or two splits as basal +45 DAS through PU. Similar findings were also reported by Shrivastava *et.al.* (1995).

The yield and yield attributes were also increased with the increasing levels of nitrogen. The head diameter, seeds $head^{-1}$ and test weight were superior under application of 120 kg N ha^{-1} than rest of the nitrogen levels. However, application of 100 kg N also produced comparable yield attributes (Table 2). The higher values of yield attributing characters have contributed higher grain and straw yield under higher levels of N. The split-application of NCU further enhanced the nitrogen and protein content in seed, yield attributes and grain and stover yield of sunflower but the oil content showed antagonistic effect with higher levels of nitrogen. In conformity to this Vasudevan *et.al.* (1995) and Ujjinaiah et al. (1998) also reported similar findings.

The higher doses and split-application of NCU might have maintained the supply of nitrogen through out the growing period of sunflower, which could have enhanced the metabolic activities, higher assimilation and more uptake of nitrogen, resulting in higher LAI, plant height, DMA and stem girth. Khan (1996) also found higher growth and yield attributes with higher levels of nitrogen applied in splits with NCU.

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ROLE OF FARM YARD MANURE APPLICATION WITH ENTISOLS ON GROWTH OF *DICHROSTACHYS CINEREA* (L) IN NURSERY

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ABSTRACT

The nursery studies on initial growth pattern of *Dichrostachys cinerea* based under different doses of FYM in degraded poor red lateritic soil have shown that survivorship of plant enhanced with increasing the availability of basic nutrient through FYM. The ratios of FYM in nursery soil (*Entisols*) used for raising the seedlings were 0(T_1), 25(T_2), 33.3 (T_3), 50(T_4), 66.7(T_5), 75 (T_6) and 100(T_7) percent comprises of seven treatments. Growth of seedlings after a month of emergence was recorded significantly higher with 66.7% FYM application (T_5) and over all total dry weight of seedling after a month of growth was recorded 6.3434 g plant^{-1}. The poorest growth performance was found in T_1 and T_2, while dry matter accumulation in different parts of seedling showed statistically insignificant differences for T_3, T_4, T_6 and T_7.

INTRODUCTION

Dichrostachys cinerea (L.) Weight & Arn, member of leguminaceae is wide spread thorny shrub or small tree in tropical Africa, tropical Asia and Australia (Anonymous, 1952). It has been recommended for shallow soils, sub-humid plains (Paroda and Muthana, 1979) and highly degraded and eroding wastelands area (Roy, *et a*l., 1984a), because of its very fast regeneration through root suckers. It is a multipurpose woody fodder species particularly for top feeding animals and holds great value in arid and semi-arid area. Plantation of multipurpose trees and shrubs especially nitrogen fixing species assume great importance in context of utilization of wastelands, non-forest area and degraded lands. But initial establishment and growth behaviour of plants always resulted after the basic nourishment from the soil (Naugraiya and Pathak, 1990). In the present paper the establishment and growth behaviour of *D. cinerea* in poor red lateritic soil supplemented by different ratios of FYM was studied

MATERIALS AND METHODS

Fresh and mature seeds of uniform size and colour were scarified by concentrated sulphuric acid (Roy *et al.*, 1984 b) to break the hard seed coat dormancy and after 24 hrs soaking in water seed were sown in containers having the capacity of 2 kg soil in first week of February. These containers were filled by mixture of red lateritic soil (*Entisols*) and well grind FYM (F) where the ratios of FYM in soil were 0, 25, 33.3, 50, 66.7, 75and 100 percent comprises of seven treatments viz; T_1, T_2, T_3, T_4, T_5, T_6 and T_7, respectively. Germination of seed was counted as emergence of plumule from the soil. The survivorships of seedlings were recorded till the one-month after emergence. After the growth of a month seedlings were harvested and measured for shoot and root length and leaves numbers. Dry matter accumulation in stem, leave and roots were also recorded after drying at 70 °C in hot air oven for 24 hrs. Characteristics of soil mixture of all seven treatments were analysed for pH, organic carbon, nitrogen and phosphorus as per the standard methods of Jackson (1967). Data were analysed for their statistical variance ratio of plant and soil characteristics and their correlation matrix (Pansey and Sukhatame, 1960).

METEOROLOGICAL STATUS

Climate of forest nursery at Baronda Farm falls under sub-humid tropics with an average rainfall of 1400 to 1600 mm and mean maximum and minimum temperature of 45 °C and 4 °C, respectively. The climatic features of study period, i.e. February to May are presented in Table-1. The mean maximum temperature was 36 $\pm$ 4.8°C with the highest 42.6°C in May and mean minimum temperature was 19.5 $\pm$ 47°C with lowest 13.3°C in February. Seasonal rains occurred during the course of study with precipitation of 75 mm in 17 days. The average relative humidity was ranged 59.5 (February) to 29.5 (May) percent. The average Sunshine duration was 9 $\pm$ 0.8 hrs per day. . The wind speed was ranged between 3 to 7.8`km hr^{-1}. The rate of evapo-transpiration was ranged between 4 to 13.5 mm while the vapour pressure was 11.5 $\pm$ 1.5mb (Table 1).

Table 1: Meteorological status during the study period of site

Month	Temp. (°C)		Rainfall		RH %	Wind	Evaporation	Sun shine	Vapour pressure
	Max	Min	mm	Days	Av.	(km hr^{-1})	(mm)	(hrs)	(mb)
J	28.3	11.5	6.6	1	62.5	2.1	3.3	8.2	10.0
F	29.1	13.3	19.0	5	59.5	3.0	4.0	8.3	10.45
M	37.5	17.0	-	-	37	3.8	7.6	10.0	10.1
A	37.7	22.0	20.2	8	39	6.6	9.6	8.2	11.8
M	42.6	25.5	35.8	4	29.5	7.8	13.5	9.6	13.35
J	33.4	24.4	446.8	15	70	12.5	7.0	2.6	20.25
J	29.1	22.6	545.2	24	86.5	12.4	4.0	1.9	22.2
Yearly			1688.2	112					

SOIL

The mixture of soil and FYM in different ratios comprise of seven treatments viz; T_1, T_2, T_3, T_4, T_5, T_6 and T_7 , where the pure soil and FYM was used in T_1 and T_7 respectively, the share of FYM was least in T_2 and it increased towards T_6 with decreasing share of soil. The pH was found maximum in T_7 (7.29) and it decreased gradually with increasing of soil content and it was 7.02 in T_1 (Table 2). Organic carbon was estimated 13.35 percent in T_7 and minimum 0.292% in T_1. Available nitrogen was distillated maximum in T_7 (586.43 kg ha^{-1}) minimum in T_1 (329.28 kg ha^{-1}). Availability of phosphorus was 81 times higher in T_7 than T_1 3.12 kg P_2O_5 ha^{-1}). The value of pH, organic carbon, available nitrogen and phosphorus was found increasing from T_1 to T_7 as the ratio of FYM increasing and soil decreasing.

Table 2: Soil characteristics

Treatments	Soil Parameter			
	pH	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})
T_1	7.02	0.29	329.28	3.12
T_2	7.26	1.14	343.29	17.94
T_3	7.35	1.45	429.63	49.83
T_4	7.48	1.60	443.29	90.36
T_5	7.68	1.73	443.31	191.63
T_6	7.72	1.79	476.67	218.12
T_7	7.79	13.35	586.43	243.83
SEm $\pm$		0.01	14.366	6.73
CD (p=0.05)		0.04	40.627	19.04

RESULTS AND DISCUSSION

The seedling emergence in different soil and FYM treatments was not found much impressive and it remained maximum 25 percent in T_4, T_5 and T_6 and minimum 10.9 percent in T_7 where the containers had pure FYM. But in case of survivorship of seedlings, it was 100 percent in T_7 followed by 85.7 and 83.3 in T_6 and T_5, respectively. The survivorship was decreased as the share of soil increased and thus lowest survivorship was recorded 28.6 percent in T_1. Thus, the results showed that a negative response of FYM for seedling emergence but positive response for survivorship (Table 5). These features showed the minimum requirement of FYM application for initial phase of establishment of plants in red soil. The fragile behaviour of soil due to FYM might be helpful for development of roots and increasing the survivorship of young plants (Joshi, 1960).

Shoot growth was found maximum in T_5 (61.0 cm) followed by T_6 and T_7 (35 & 34 cm). There was statistically insignificant difference among T_3, T_4, T_6 and T_7.The minimum shoot height was recorded in T_1 (9.25 cm) and T_2 (9.5 cm). Almost statistically similar trend was seen in dry matter production of shoot, where the maximum was 2.173 g plant^{-1} in T_5 and the minimum was 0.057 g plant^{-1} in T_1 (Table 3).

Table 3: Growth performance of seedlings of *D. cinerea* in different soil mixture

Treat.	Emergence (%)	Survival (%)	Stem (cm)	Leaves (no)	Root (cm)	Dry weight (g plant^{-1}) Stem	Leaves	Root	AG	Total	s/r
T_1	17.9	28.6	9.25	4.00	28.00	0.0570	0.0765	0.1860	0.1335	0.3195	0.71
T_2	21.4	40.7	9.50	4.50	37.00	0.0890	0.1548	0.6689	0.2438	0.9127	0.36
T_3	21.4	66.7	28.33	12.50	33.33	0.6660	0.8711	0.5270	0.5371	2.0641	2.92
T_4	25.0	66.7	31.50	17.00	41.50	0.9967	1.0263	0.7323	2.0230	3.0493	2.76
T_5	25.0	83.3	61.00	33.00	62.50	2.1725	2.4998	1.6711	4.6723	6.3434	2.79
T_6	25.0	85.7	35.00	13.33	41.00	0.8443	1.0095	0.5983	1.8538	2.4521	3.10
T_7	10.9	100	34.00	11.67	42.33	1.0974	0.6843	0.8560	1.7817	2.6377	2.08
SEm ±			5.18	3.96	4.25	0.2392	0.2526	0.1095	0.4559	0.5115	0.58
CD (p=0.05)			14.64	11.21	12.01	0.6766	0.7143	0.3097	1.2893	1.4464	1.65

Number of leaves and their dry matter was recorded maximum in T_5 (33 leaves plant^{-1} and 2.4998 g plant^{-1} respectively). While minimum number of leaves and dry matter were 4 leaves and 0.0765g plant^{-1} respectively in T_1, which were insignificant statistically from all the treatments except T_5. Growth in root length and its dry matter was again found maximum in T_5 and minimum in T_1 with significant difference while rests of the treatment were insignificant. Over all total dry matter accumulation in plants were in order to $T_5 > T_4 > T_6 > T_7 > T_2 > T_1$, where the results among T_2, T_3, T_4, T_6 and T_7 were insignificant statistically (Table 4).

The soil pH, organic carbon, available nitrogen and phosphorus of different treatments were tested for their correlation with different characteristics of growing seedlings of *D. cinerea* and presented in Table 5. Perusal of table showed the statistically significant positive correlation of plants survivorship with pH, available nitrogen and phosphorus; stem height with pH. While, statistically significant negative correlation was calculated between seedlings emergence and soil organic carbon.

Table 4: Analysis of variance for growth characteristics of seedlings of *D. Cinerea*

Source	**DF**	***Mean um of Square***								
		Stem	**Leaves**	**Root**	**Dry weight (g/Plant)**					
		(cm)	**(No.)**	**(cm)**	**Stem**	**Leaves**	**Root**	**AG**	**Total**	**S/R**
Replications	2	52.89	35.29	14.62	0.1178	0.5370	0.0643	0.9949	1.5424	0.55
Treatments	6	928.78	283.91	353.90	1.5686	1.9340	0.6287	6.7469	1.1397	3.60
Error	12	80.42	47.15	54.09	0.1717	0.1914	0.0360	0.6235	0.7848	1.02

Table 5: Correlation matrix (r) between soil and growth characteristics for *D. cinerea*

Parameters	**Emergence**	**Survival**	**Stem**	**Leaves**	**Root**	**Dry weight (g/p)**					
	(%)	(%)	(cm)	(No)	(cm)	**Stem**	**Leaves**	**Root**	**AG**	**Total**	**S/r**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
pH	-0.0102	*0.9728*	*0.7729*	0.7000	0.6302	0.7341	0.6126	0.6333	0.6819	0.6812	0.6742
OC	*-0.7982*	0.6489	0.1878	0.2179	0.1313	0.2650	-0.0416	0.1719	0.1055	0.1229	0.0607
N	-0.3779	*0.9443*	0.5686	0.4985	0.3667	0.5369	0.3421	0.3618	0.4420	0.4300	0.5849
P	-0.1287	*0.9394*	0.7384	0.6812	0.5867	0.7306	0.5596	0.5632	0.6518	0.6411	0.6099

Note: Values in bold & italic letter are significant at 5%

Leguminous species mostly prefers light soil for their optimum growth than heavy and water logged soil. The soil rich in nutrient content gave better initial growth of the species (Roy *et al.*,1985). The use of FYM up to certain level in soil is found to be best for growth and development. The availability of some growth promoting substances in FYM also found to be helpful to excel rate the growth of plants (Pekary and Kiskeri, 1980). The pure FYM has enough organic materials, which tends to hold maximum water (Joshi, 1960) and are found to be responsible for creating water logged condition as well as media for reacting the molecules causing toxicity to growing plants, but when FYM mixed with very poor soil which has tendency to become hard and compact on drying, gave intermediate soil environment to growing young plants with appropriate nursing conditions.

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PERFORMANCE STUDY OF MANUALLY OPERATED LOW LIFT HAND PUMP

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ABSTRACT

Experiments were conducted at IGKV, Raipur during 1998-2003 in the winter season to determine performance characteristics of different types of manually operated low lift hand pumps. It was found that the discharge capacity of the pump depends on number of strokes, stroke length and volume of inlet cylinder chamber. The discharge of pump varies between 8300 lit h^{-1} for 1 m suction heights to 4400 lit h^{-1} for 5 m suction heights. Discharge rate of the pumps decreases with the increase in operating heads. The force requirement was inversely proportional to the number of revolution per hour. The value of force requirement was obtained in the range of 34 N to 85 N for suction height from 1 m to 5 m. There was a considerable decrease in discharge and increase in force requirement if the pumps were used above 5 m suction height. Looking to its popularity and suitability to small farmers of Chhattisgarh, Govt. of Chhattisgarh listed this pump under subsidy items.

INTRODUCTION

Chhattisgarh State of India is an area of tribal and backward farmers. Rainwater availability is quite high, ranging from 1200 mm to 1600 mm with annual average of 1400 mm. This amounts to about 20 million hectare-meters of rain water which if exploited to even 25% would be sufficient to irrigate entire cropped area in the Chhattisgarh (Shukla, 1992). Since most of the farmers are poor and having small land holdings, therefore methods of exploiting water have to be cheaper less sophisticated and easier to use. Due to lack of adequate mechanical skill amongst farmers, poor economic condition and lower recharge capacity of open wells; use of high capacity pumps are not suitable to small land holdings. Low lift hand pump helps farmers to lift water from rivers, ponds, canals, open wells and tube wells. When the height of lift is within the range of 1 to 4 m depth. The pump is operated by a single person, it is easy to install and can be repaired by the farmers themselves. Pump has environmental advantage over the mechanical pumps. Moreover, in India, the cost of importing oil is a limiting factor (Verma, 2000). Low lift hand pump reflects the capacity to solve the irrigation problem of small farmers. It is effective for 1 ha or less land holdings particularly in remote areas where electrical network is not properly available.

The cost of lifting water by animal power is about 10 to 20 times more than with electric motors. Manually operated water lifts are costliest, being 3 to 4 times more than animal operated device. In spite of the economic disadvantages, man and animal power continue to remain the major energy sources in domestic water supply and small-scale irrigation in developing countries (Michael and Khepar, 1994). Sahu (1987) investigated that at lower range of operating head (less than 2.5 m), 104 mm diameter PVC pipe gives highest discharge at higher efficiencies than the other two pipes (100 mm dia. GI pipe and 86 mm dia PVC pipe). International Development Enterprises reported that small and marginal farmers in South Asia have purchased 1.2 million Low lift pumps. Discharge of this pump ranges from 4500 to 6000 lit h^{-1} it is best suited up to 25 feet (8m) below the ground (Anonymous, 1997).

There is a large demand from the farmers for low lift hand pumps in Chhattisgarh. Looking to its popularity and suitability for small farmers, Govt. of CG listed this pump under their subsidy items. According to the information from state Govt., about 10,000 units of low lift hand pumps were supplied to the farmers of Chhattisgarh during year 1998-2004. (Directorate of Agril. Engineering, Govt. of CG, 2002-03). Based on these observations, the current study was conducted in the Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya, Raipur during the year 1998 - 2003 in the winter season from October to December, to determine the performances characteristics of the manually operated low-lift hand pumps.

Table 1: Specification of low lift pump taken for the study

Specification	**Pump No.**		
Pump	**Pump$_1$**	**Pump$_2$**	**Pump$_3$**
Body	CR Sheet	HR Sheet	GI Sheet
Cylinder Chamber			
Diameter (mm)	320	320	320
Height of Suction Chamber (mm)	150	150	150
Height of Delivery Chamber (mm)	150	150	150
Suction dia (mm)	68	80	68
Plunger (Cast Iron)			
Weight of Plunger with valve (kg)	11.920	10.625	11.850
Type of valve (Rubber)	Flapper	Flapper	Flapper
Dia (mm)	450	450	450
Discharge Spout (mm)			
Width	210	220	210
Length	135	140	130
Height	90	100	90
Supporting Post Length (mm)	215	230	215
Valve (mm)			
(i) Inlet dia	120	120	120
Thickness	5	5	5
(ii) Outlet dia	140	140	140
Thickness	10	10	10
Handle			
Length (mm)	2000	2250	2000
Height	adjustable	adjustable	adjustable
Stand (mm)			
Height	535	455	455
Length	560	800	560
Width	390	300	390
PVC Suction pipe			
Length (m)	9.0	9.0	9.0
Diameter (mm)	65	75.6	65
Thickness (mm)	3	3	3

MATERIALS AND METHODS

Three different types of low lift hand pumps provided by the Department of Agricultural Engineering, Government of MP were selected to conduct the experiments. The details of pump are shown in Fig. 1 and 2 and specifications are given in Table 1. Five operators of average health were used to test all the pumps. The experiments were conducted at various heads. A pre-calibrated tank was used for measurement of discharge. A revolution counter was fitted to count the number of revolutions with piston rod. A load cell with indicator was used to find out force required to run the pump. The pump was run for a day (8 h) for each head and each operator. The replicated data observed for discharge, revolution and force at different heads were analysed and average data are presented in Table 2.

Table 2: Results of performance study of manually operated low lift hand Pump

Suction height (m)	Pump$_1$			Pump$_2$			Pump$_3$		
	Force (N)	Rev. (No h^{-1})	Discharge (lit.h^{-1})	Force (N)	Revolution (No h^{-1})	Discharge (lit. h^{-1})	Force (N)	Revolution (No h^{-1})	Discharge (lit. h^{-1})
1.0	36.8	1996	7490	34.0	2026	8314	34.5	2004	7940
2.0	47.5	1935	6060	42.2	1968	6687	45.8	1982	6291
3.0	55.9	1842	4778	53.0	1860	5389	58.6	1854	4986
4.0	66.8	1785	4001	64.8	1800	4395	65.4	1796	4048
5.0	84.4	1640	3148	86.2	1602	3386	80.1	1615	3424
6.0	96.9	1538	2765	105.6	1509	2801	94.2	1551	2865
7.0	119.3	1425	2206	123.6	1403	2030	116.4	1438	2328
8.0	130	1295	1790	139.9	1192	1617	128.5	1282	1847

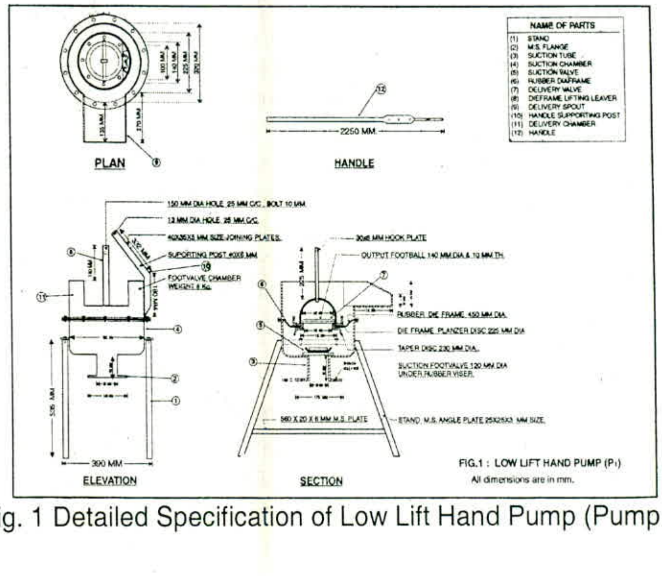

Fig. 1 Detailed Specification of Low Lift Hand Pump (Pump $_2$)

RESULTS AND DISCUSSION

The performance of the low lift hand pumps at various operating heads ranging from 1 m through 8 m are presented in Fig. 3 to 5

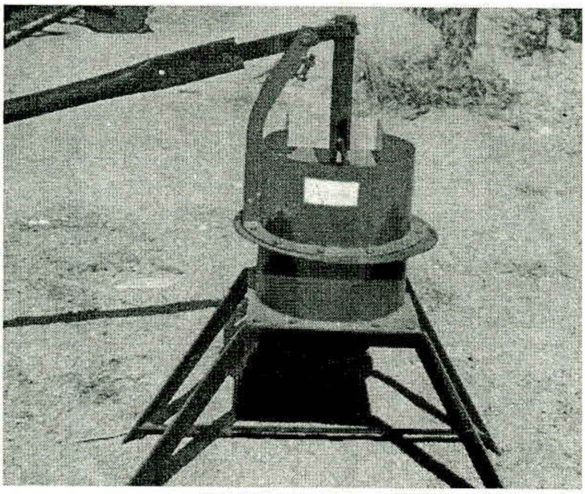

Fig. 2 Low Lift Hand Pump

EFFECT OF SUCTION HEIGHT ON DISCHARGE OF PUMP

It was observed that in all the pumps (P_1, P_2 and P_3) discharge rate were decreased with the increase in operating heads (Fig.3). The capacity of pumps depends on the *number of* strokes, stroke length and size of cylinder chamber. These pumps utilize atmospheric pressure to raise the water into pump column. The highest discharge rate was observed for pump P_2 followed by pump P_3 and P_1 up to 4 m of suction height. The discharge of pump varies between 8300 lit h^{-1} for 1m suction heights to 4400 lit h^{-1} for 5m suction heights. The decrease in rate of discharge of pump was found higher at lower suction height. This may be due to the force requirement per stroke was within the capability of the operator. Hence, the decrease in number of strokes were not much affected at lower suction height .The range of rate of decrease in discharge rate of lifted water were 1600 to 1400 lit m^{-1}, 1350 to 850 lit m^{-1}, 1000 to 700 lit m^{-1} and 800 to 600 lit m^{-1} up to 2m, 3m, 4m and 5m suction height respectively. It was observed that 80mm suction dia. pump P_2 gave higher discharge, than 68mm suction dia pump P_1 and P_3 at low operating head conditions. However, under high suction height (greater than 4 m) conditions pump P_1 and P_3 gave higher discharge as compared to P_2. This may be attributed due to the fact that the leakage losses at higher heads were more pronounced in case of wider suction diameter pipe. Another reason of this trend was that number of revolution per hour decreased with the increase in diameter of suction pipe and operating head.

EFFECT OF SUCTION HEIGHT ON FORCE REQUIREMENT

The variation of the operating force for different suction height of the pump was tested for all the three pumps. The results of the study have been illustrated in Fig. 4. It was observed that the operating force increased with the increase in operating head for all the pumps. It was noticed that force requirement for pump P_1 and P_3 was more as compared to pump P_2 because length of handle of pump P_1 and P_3 were 2000 mm whereas, length of handle of pump P_2 was 2250 mm. Therefore, the force requirement for pump P_1 and P_3 was more as compared to pump P_2 for same suction height.

Table 3: Total discharge in a day by using single and double operator

Suction Height (m)	Total Discharge in a day (lit day^{-1})					
	$Pump_1$		$Pump_2$		$Pump_3$	
	Single Operator	Double Operator	Single Operator	Double Operator	Single Operator	Double Operator
2.0	34000	43000	42000	53000	36500	45000
4.0	29500	35000	31000	40500	28500	35000
6.0	18500	27000	17000	24000	19000	26000

INTERRELATIONSHIP BETWEEN SUCTION HEIGHT, FORCE REQUIREMENT AND DISCHARGE

It was noted that force requirement was inversely proportional to the revolution per hour. Discharge of pump P_2 was more up to 4m of suction height due to number of revolutions were more in case of pump P_2. This may also be due to the force requirement within the capability of an operator and use of wider suction diameter pipe and lower weight of plunger P_2. On the other hand at operating head above 4 m, the weight of water column and the force requirement increased significantly. Hence number of revolution decreased. These effects cause lower discharge at higher (greater than 4 m) suction height.

INTERRELATIONSHIP BETWEEN SUCTION HEIGHT, NUMBER OF REVOLUTION AND DISCHARGE

The variation of the number of revolution and discharge were tested under varying conditions of operating head. It was noticed that number of revolution decrease with the increase of suction height. It was also noticed that as suction height increases, rate of revolution of handle would decrease and hence discharge decrease (Fig.5).

COMPARISON OF DISCHARGE OF PUMP IN A DAY BY USING SINGLE AND DOUBLE OPERATOR

All the pumps were tested by using single operator and two operators for suction height of 2, 4 and 6 m. The results are presented in Table 3. The highest discharge rate for a day (8 h, 1-h rest) work was observed for pump P_2 up to 4m of suction height. The discharge rate varies between 42000 lit day^{-1} to 31,000 lit day^{-1} for 2 to 4 m of suction heights respectively when operating pump with single operator. If two people operate alternately the pump at 2 to 4 m of suction height discharge rate varies between 53000-40,000 lit day^{-1}. The relationship between suction height and discharge for whole day work when operating by single operator is shown in Fig.6. When the pumps were operated by two operators alternatively for whole day work the effect of suction height on discharge is shown in Fig. 7. A considerable decrease in discharge was observed if the low lift hand pumps were used above 5 m of suction height. Therefore, these pumps are suitable for pumping water when level of water does not exceed 5 m. Looking to the discharge of the pump it can be recommended for small land holdings farmers to lift water from rivers, ponds and canals up to 3-4 m depth. It will be good asset to those farmers where electricity supply is not available to the farmers' field.

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EFFECT OF DIFFERENT TILLAGE AND WEEDING METHODS ON YIELD OF RAINFED TRANSPLANTED RICE IN BASTAR REGION

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ABSTRACT

An experiment was conducted during *kharif* 1997-98 in split plot design at Zonal Agricultural Research Station, Kumhrawand, Jagdalpur, Chhattisgarh state to assess the effect of different tillage and weeding methods on rice grain yield in rainfed condition. He- buffalo was used as power source for tillage implements. Five different tillage treatments viz. Animal drawn M P plough + rotary puddler + plank (T1); Animal drawn M B plough (15 cm) + rotary puddler + plank (T2); Animal drawn deshi plough + rotary puddler + plank (T3); Animal drawn deshi plough alone + plank (T4); Animal drawn M B Plough (9 cm) + rotary puddler + plank (T5) as main plot treatments and three weeding methods viz. Manual paddy weeder (W1); Hand weeding (W2); No weeding (W3) as sub-plot treatments were chosen for the study. The actual field capacity of ploughing and puddling combined was found to be the highest under treatment, T2, whereas it was the lowest under farmer's practice T4. It is very well reflected by the energy input values estimated for different treatments which follows the trend $T2 < T1 < T3 < T4 < T5$. On the basis of yield, the tillage treatments T1, T2 and T3 were at par, whereas T1 was significantly superior over farmer's practice. The puddler was found to be approximately one and half times more efficient puddling device as compared to farmer's practice of puddling by deshi plough alone. All the weeding treatments differed significantly from one another on the basis of yield. However, the manual paddy weeder was proved to be time saver and energy efficient. It recorded second highest yield (28.53 q ha^{-1}) next to hand weeding (31.11 q ha^{-1}). Keeping the draft requirement within the range of local animals i.e. He- buffalo, the treatments T2 and T1 were found to be the right choice being energy efficient which also produced higher rice yield.

INTRODUCTION

Puddling is energy intensive tillage practice. It is prerequisite for wetland transplanted rice cultivation. Puddling is done after the onset of monsoon when sufficient rainwater accumulates in bunded fields. This process creates soft soil bed and impervious surface layer for easy establishment of transplanted seedlings and for reducing the loss of water through percolation. It helps to check loss of nutrients and maintains standing water. In addition, it helps to eradicate weeds and incorporates manures and fertilizers into the soil. Draught animals (bullocks/ he buffaloes) have an important place in our agricultural farming and will continue to have the same for many more years to come specially in areas like southern part of Chhattisgarh state i.e. Bastar region (Dave, 1995). Puddling significantly increases rice yield (Manian and Jivaraj, 1989, Salokhe et al., 1993, Sanchez, 1973, Sharma et al., 1988, Razzaq, 1987). Tillage influences energy parameters in rice cultivation (Patel and Das, 1992). Average loss of rice yield was 17% under transplanted condition due to weed infestation (Rao and Pillai, 1988). Keeping in view the energy crisis, availability of he buffaloes as draft animals, low power availability of 0.34 kw ha^{-1} (Anonymous, 1995) in the region and weeds problem in rainfed transplanted rice cultivation, it was considered appropriate to study the effect of five different animal drawn tillage implements and three weeding treatments on energy use pattern and yield of rainfed transplanted rice.

MATERIALS AND METHODS

The experiment was conducted at the Zonal Agricultural Research Station, Indira Gandhi Krishi Vishwavidyalaya, Kumhrawand, Jagdalpur during *kharif* season (1997-98) under rainfed situation. Five different combinations of animal drawn plough and rotary puddler along with plank were used as tillage treatment under main plot and three treatments of weeding were chosen as a sub plot treatments (Table 1). Rice variety IR- 36 was transplanted at 20 x 15 cm spacing. Recommended doses of fertilizer i.e. NPK at the rate of 60:40:20 kg ha^{-1} were given. Full doses of phosphorous and potash with one-third dose of nitrogen was applied at the time of puddle bed preparation. The remaining nitrogen was applied in two splits at tillering and panicle initiation stages. The energy consumption was estimated as suggested by Mittal and Dhawan (1988). The puddling index, depth of puddling and percolation rate of water was measured as per the standard procedure. The performance of implements was noted on the basis of capacity to cover the area per hour.

Table 1: Details of operation wise treatment

Treatment	E
Main plot treatment	
M P Plough + rotary puddler + plank	T1
M B Plough + rotary puddler + plank	T2
Deshi Plough + rotary puddler + plank	T3
Deshi Plough alone + plank	T4
Small M B Plough + rotary puddler + plank	T5
Sub plot treatment	
Manual paddy weeder	W1
Hand weeding	W2
No weeding	W3

RESULTS AND DISCUSSION

IMPLEMENT PERFORMANCE

The combined effective field capacity of plough and puddler was found highest under treatment T2. By using this treatment it was possible to prepare a unit hectare of land for transplanted paddy in 10.23 days. The lowest effective field capacity was observed under treatment T4 i.e. farmer's practice. Trends of the treatments can be expressed as: T2>T1>T3>T5>T4. The puddling by M.B. Plough + rotary puddler + plank (T2) was found superior followed by M P Plough + rotary puddler + plank (T1) on the basis of higher puddling index, deeper depth of puddling and more reduction in water percolation as against the farmer's practice (Table 2).

ENERGY USE PATTERN

The energy required to puddle the field for transplanted rice cultivation is presented in Table 3. The energy input was the lowest under T2 followed by T1, T3, T4 and T5. Use of rotary puddler with the combination of M B plough reduced the tillage energy requirement by 38.86 % compared to farmer's practice. It was also observed that by using the same puddler in combination with deshi plough saved the tillage energy by 12.90% compared to the use of deshi plough alone (T4). On an average the total energy input was the lowest under treatment T2 (8002.20 MJ ha^{-1}) whereas, it was the highest under farmer's practice (T4). It is reflected by recording higher output-input energy ratio and lower specific energy of main product under the treatment (T2).

Table 2: Performance of tillage treatments (buffaloes as source of farm power)

Treatment	Effective field capacity (ha h^{-1})	Depth of puddling, (cm)	Puddling index (%)	Reduction in percolation rate of water compared to farmer's practice (%)	Workdays required per ha.
T1	0.0196 + 0.0234	12.69	40.90	14.02	11.71
T2	0.0236 + 0.0253	13.19	46.21	14.27	10.23
T3	0.0176 + 0.0234	10.15	36.79	1212	12.44
T4	0.0176 + 0.0169	10.13	30.56	-	14.49
T5	0.0153 + 0.0223	10.05	32.63	2.95	13.76

Table 3: Energy use pattern under different tillage treatments of rainfed rice cultivation

Parameter	T1	T2	T3	T4	T5
Energy for field preparation (MJ ha^{-1})	2466.25 (- 18.62 %)	2106.94 (- 38.86 %)	2591.38 (- 12.90 %)	2925.80 (NA)	2977.14 (+ 1.75 %)
Total input energy (MJ ha^{-1})	8387.51	8002.20	8440.79	8881.80	8876.65
Specific energy of main product (MJ q^{-1})	115.68	114.08	129.16	144.13	173.06
Output-input energy ratio	11.65	11.81	10.43	9.35	7.78
Yield (q ha^{-1})	32.24	31.19	29.06	27.40	22.81

Figures in parenthesis represent percent reduction (-) or percent increase (+) in energy input as compared to farmer's practice

YIELD ANALYSIS

Table 4 shows the effect of different treatments on rice grain yield. On the basis of puddling treatments, the treatment T1 recorded significantly higher grain yield compared to farmer's practice. However, the treatments T1, T2 and T3 were at par on the basis of yield.

Under treatment T5 grain yield was recorded significantly lower compared to farmer's practice. This may be due to the poor initial ploughing by small M.B. plough followed by puddling. The treatments T1, T2 and T3 have recorded 17.66, 13.83 and 6.05 per cent higher rice grain yield, respectively compared to treatment T4 i.e. farmer's practice. The effects of weeding treatments were found significant. The hand weeding treatment recorded the highest rice yield followed by mechanical weeding with manual paddy weeder and no weeding treatment. However, manual paddy weeder was found as time and energy saving treatment compared to other treatments.

Table 4: Effect of different treatments on rice grain yield

Main Treatment	**Rice grain yield (q ha^{-1})**
M.P. Plough + rotary puddler + plank	32.24
M.B. Plough + rotary puddler + plank	31.19
Deshi Plough + rotary puddler + plank	29.06
Deshi Plough alone + plank	27.40
Small M.B. Plough + rotary puddler + plank	22.81
CD (0.05)	4.83
Sub treatment- Weeding	
Manual paddy weeder	28.53
Hand weeding	31.11
No weeding	25.97
CD (0.05)	1.46

CONCLUSIONS

- The puddling treatments namely M.P. Plough + rotary puddler + plank, M.B. Plough + rotary puddler + Plank and Deshi Plough + rotary puddler + plank were found at par on the basis of grain yield.
- Based on energy parameters and puddling quality the treatment "M.B. Plough + rotary puddler + Plank" stood first followed by M.P. Plough + rotary puddler + plank and Deshi Plough + rotary puddler + plank.
- Weeding treatments differed significantly from each other on the basis of grain yield.

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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON PRODUCTIVITY AND PROFITABILITY OF RICE-VEGETABLE CROPPING SYSTEM

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ABSTRACT

The integrated nutrient management in rice vegetable cropping system proved superior over application of chemical fertilizer. Application of 75% N though inorganic + 100% P_2O_5 and K_2O + 25% N though green manuring + cowpea intercropping (for green pods) with cabbage produced significantly higher yield of rice and cabbage equivalent yield, which was comparable with application of 75 per cent N + 50 percent P and K through in organic fertilizer + 25 per cent N though G.M. + cowpea intercropping (for green pods) with cabbage. However, application of 125 % RDF (80:50:40) NPK kg ha^{-1} RDF produced maximum yield of rice but was at par with integrated nutrient management practices. The soil bulk density was drastically reduced from 1.46 mg m^{-3} to 1.36 and 1.35 mg m^{-3} under integrated nutrient management over supplement through pure chemical fertilizer, during 2003-04 and 2004-05, respectively.

INTRODUCTION

The nitrogen application is essential for the growth and development of plants, which correspondingly boosts up the yield attributes and yield of the crop. Under low-land rice ecosystem, the recovery of applied nitrogen is very meagre and its availability is observed up to 30 only; and rest is lost through leaching or by other means. To avoid such important and costlier element, the concept of integrated nutrient management was introduced, which proved its efficacy not only in reducing the losses of applied N but also helped in cutting the N doses applied (Bajpai, 2000). The integrated nutrient management proved to be the best method of nutrient supplement for submerged soil especially the puddled rice soil as it improved the soil health by reducing soil bulk density, increasing organic carbon, microflora development, and increased the availability of native and soil fixed nutrients (Budhar and Palaniappan, 1997)

MATERIALS AND METHODS

The investigation was carried out at the Instructional Farm of IGAU, Raipur during *kharif* and *rabi* seasons of 2003-04 and 2004-05. The experimental soil was clay-loam having low nitrogen, medium phosphorus and medium potassium availability and was chemically reacted neutral with a pH of 7.1. The experiment was framed out under randomized block design, with three replications. Six treatment of N management viz,. application of 100% recommended dose of fertilizer (RDF) through inorganic form (80:50:40 kg NPK ha^{-1} to rice and 120:60:40 kg NPK ha^{-1} to cabbage) (T_1), 75% of recommended N and 100% P&K as inorganic + 25% of recommended N through FYM (T_2), 75% of recommended N and 100% P&K as inorganic + 25% N through green manuring + cowpea intercropping @ 50 kg seed with cabbage (T_3) 75% N and 50% P and K as inorganic + 25% N through G.M. + cowpea intercropping with cabbage (T_4) 50% N P & K through inorganic + 25% N through G.M. + 25% N through FYM (T_5) and 125 % RDF + 5t FYM ha^{-1} (T_6). The cowpea was used as green pod yield for table purpose and then the plants were incorporated into the soil.

Table 1. Effect of integrated nutrient management on production of rice- vegetable cropping system

Treatment	Yield (q ha^{-1})							
	Rice (grain)				Cabbage (green vegetable)		Cowpea (green pod)	
	2003-04		2004-05		2003-04	2004-05	2003-04	2004-05
	Grain	Straw	Grain	Straw				
T_1 100% RDF rice: 80:50:40 cabbage: 120:60:40	31.73	41.24	33.41	43.84	535.64	511.77	-	-
T_2 75% N Inorg +25% N FYM +100% P&K	32.37	45.96	34.72	49.33	476.13	456.14	-	-
T_3 75% N Inorg + 25% N GM+ 100% P&K + cowpea (rabi)	34.99	49.73	36.25	51.41	709.45*	617.32*	43.34	39.48
T_4 75% N Inorg + 25% N (G.M.) +50% P&K + cowpea (rabi)	33.32	46.46	34.44	48.07	684.97*	595.53*	41.28	37.92
T_5 50% N Inorg + 25% N FYM + 25% NGM + 50% P&K	33.81	43.95	36.11	47.71	432.44	417.56	-	-
T_6 25% Additional nutrients than RDF + 5t ha^{-1} FYM (kharif)	35.89	49.89	38.82	53.62	536.78	520.94	-	-
CD (P=0.05)	1.90	2.17	2.68	3.91	39.31	42.68	NS	NS

* Cabbage yield + Cabbage equivalent of cowpea

Table 2. Effect of plant residues incorporated in soil and integrated nutrient management on soil bulk density and carbon content, under rice-vegetable cropping system

Treatment	Quality of crop residues incorporated ($q\ ha^{-1}$)				Soil bulk density ($Mg\ m^{-3}$)				Soil organic carbon content (%)	
	Cabbage		Cowpea		Before rice		After cabbage		Before rice	After cabbage
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
T_1 100% RDF rice: 80:50:40 cabbage: 120:60:40	36.36	35.11	-	-	1.46	1.45	1.44	1.44	0.59	0.61
T_2 75% N Inorg +25% N FYM +100% P&K	28.24	26.33	-	-	1.46	1.44	1.41	1.40	0.59	0.63
T_3 75% N Inorg + 25% N GM+ 100% P&K + cowpea (rabi)	29.34	24.16	35.39	32.18	1.46	1.43	1.40	1.40	0.59	0.65
T_4 75% N Inorg + 25% N (G.M.) +50% P&K + cowpea (rabi)	27.4	26.6	33.17	29.96	1.46	1.43	1.38	1.37	0.59	0.66
T_5 50% N Inorg + 25% N FYM + 25% NGM + 50% P&K	29.18	23.37	-	-	1.46	1.42	1.36	1.35	0.59	0.68
T_6 25% Additional nutrients than RDF + 5t ha^{-1} FYM (*kharif*)	38.14	35.86	-	-	1.46	1.45	1.43	1.43	0.59	0.64

Table 3: Effect of integrated nutrient management of economies of rice-vegetable cropping system.

Treatment	Gross Income (Rs. ha-1)				Net Income (Rs. ha^{-1})				Net Income of cropping system (Rs ha^{-1})	
	Rice	(Grain+ Straw)	Vegetable	Cabbage + Cowpea	Rice		Vegetable			
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
T_1 100% RDF rice: 80:50:40 cabbage: 120:60:40	20462	22220	48208	61412	10462	12220	34393	47597	44855	59817
T_2 75% N Inorg +25% N FYM +100% P&K	21573	23299	42852	54736	11323	13049	29587	41472	40910	54521
T_3 75% N Inorg + 25% N GM+ 100% P&K + cowpea (rabi)	22761	24320	62678	72243	12011	13570	43701	54178	55224	66348
T_4 75% N Inorg + 25% N (G.M.) + 50% P&K + cowpea (rabi)	21649	23067	62821	73298	11599	13017	43213	52778	55300	67195
T_5 50% N Inorg + 25% N FYM + 25% NGM + 50% P&K	21808	24051	38920	50107	11408	13651	25050	36237	36458	49888
T_6 25% Additional nutrients than RDF + 5t ha^{-1} FYM (*kharif*)	23311	25973	48310	62986	12461	15123	33435	47638	45896	62761

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The 6 to 8 leaves of cabbage head and stubbles were also removed and incorporated into the soil. The green manuring was applied to rice crop only and its residual effect was studied.

The grain and straw yield of rice, green pod yield of cowpea and fresh yield of cabbage were noted and the cowpea yield was converted as cabbage equivalent yield. The cost of inputs and output were used as prevailing rates of IGKV Farm of each year to calculate the profitability of the cropping system. The rice HMT was used as *kharif* crop while, Bahar Hybrid (F_1) variety of cabbage and local cowpea were used for rabi crop treatments. The rice was transplanted on 25th July 2003 and 10th August 2004, while cabbage was transplanted and cowpea intercropped on 15th Nov. 2003 and 2nd Dec. 2004.

RESULTS AND DISCUSSION

The integrated nutrient management significantly increased the yield of rice and straw as well as the cabbage and cabbage equivalent yield of cowpea over 100% RDF (Table 1). Application of 75% of recommended N + 100% P & K an inorganic 25% N through G.M. + cowpea intercropping (T_3) produced maximum rice (34.99 & 36.25 ha^{-1}) and cabbage (709.45 & 617.32 q ha^{-1}) which also gave maximum net profit of Rs. 55.300 & 66348 ha^{-1} followed during 2003-04 & 2004-05 respectively over 100% RDF (T_1) (Table 3). Application of 75% N and 50% P & K through inorganic + 25% N through G.M. + cowpea intercropping (T_4) which produced at par yield (rice 33.326 34.44 q ha^{-1} and cabbage equivalent yield of 684.97 & 895.53 q ha^{-1}) over application of 100% RFD (T_1) and 25% additional than RFD (T_6). However, yield of rice and cabbage, the treatment (T6) produced maximum grain and straw yield of rice under application of 100% RFD during both the years.

The initial soil bulk density (1.46 Mg m^{-3}) was reduced to 1.35 and 1.36 Mg m^{-3} due to integrated management as compared to application of chemical fertilizer during both year respectively (Table 2). The incorporation of G.M., FYM and crop residues might have added extra organic matter into the soil, which might have reduced the bulk density of soil and increased the microflora which converted the applied and organic nutrient foster and made more available than direct application of inorganic fertilizers. Budhav and Palaniappan (1997) and Urkurkar *et al.* (2004) have also reported the higher net profit under rice vegetable cropping system and reduction in soil bulk density, when integrated nutrient management was used as compared to application of nutrients through inorganic forms. In addition to this, results indicated 25% to 50% saving of fertilizer inputs without reduction in yield and net profit but also improved the soil health. Further, it was observed that soil carbon content (%) increased with the use of GM, FYM and crop residues, over application of inorganic only. However, maximum soil carbon content have been increased in T_5, where 50% N was applied through inorganic sources and 25% N through FYM and 25% N through GM (Table 2).

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ASSESSMENT OF LOSSES IN POST HARVEST OPERATIONS OF WHEAT CROP IN CHHATTISGARH

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ABSTRACT

The problem of grain losses in crops has received attention in developing countries. Grain losses may be classified into pre-harvest, harvest, and machine loss. It is important to identify where harvest and threshing losses are occurring, because once it is identified measures can be taken to eliminate or minimize the losses. The experiment for the estimation of pre and post harvest losses of three varieties of wheat was conducted in the experimental field of IGKV, Raipur. In the experiment three methods of harvesting and two methods each for threshing, transportation and cleaning/ winnowing were used and their effects were observed on losses. The harvesting loss was minimum under sickle harvesting (0.71 %) followed by vertical conveyor reaper (1.06 %) and tractor mounted reaper (1.12 %) during wheat harvesting. The transportation of wheat by manually system recorded highest loss (2.05 %) compared to mechanical system i.e. tractor trolley (0.47 %). The threshing loss was recorded on higher side in mechanical thresher (4.11 %) compared to manual system (2.76 %). On the other hand the pre harvest losses varied from 0.38 to 0.72 percent, bundling loss from 1.32 to 1.52 percent and cleaning/winnowing loss varied from 0.28 to 1.76 per cent. However, the total loss was in the range of 8.03 to 9.25 per cent.

INTRODUCTION

The area under wheat has remained constant around 220 million ha. and its production has increased from 335 million tonnes (in 1975) to 624 million tonnes (in 2004) due to the development of better varieties, adoption of improved systems of crop management and better supplies of inputs; like water, fertilizers and crop protection practices (FAO, 2004). China (29 million ha) has the largest area followed by India (27 million ha) and USA (22 million ha) for wheat crop. In India, wheat is grown in almost all the states in northern and central India. Uttar Pradesh ranks first in respect of area (9.23 million ha.), with total production (23.17 million tonnes); whereas Punjab ranks first in productivity (4.33 tonnes ha^{-1}).

The problem of grain losses in crops has received attention in developing countries. The urgency of increasing food grain availability, finding food grain substitutes, and greater emphasis on the efficiency of resource use in farming, necessitates the reduction of losses in wheat (*Chaudhary,* 1979; *Tripathi,* 1979; *Iqbal et al.,* 1980; *Devranjani,* 1981; *Moshabir* and *Khan*, 1981; *Ali* and *Ojha*, 1982). It will improve returns to the farmer by higher yields. The benefits of high production of wheat can be utilized by minimizing the losses in wheat from production to consumption. Grain losses may be classified into pre-harvest, harvest and machine loss. Pre-harvest losses occur before the harvesting starts because of birds, wind, rain or other environmental factors. The harvest losses are those, which occur during harvesting and transport of harvested crop to the threshing yard. Machine losses are those that occur because of mechanical thresher or combine, which is not adjusted and operated properly (*Bukhari et al.*, 1983).

There is a lack of information on specific data about losses in harvest and post harvest operations of wheat in different agro- climatic zones of the Chhattisgarh state. Due to lack of awareness of scientific methods of processing and preservation practices, pattern and extent of wastage/ losses are important if one wishes to design ways and means of minimizing these losses or to introduce mechanization within the available frame work. Further, it is important to understand the economics of the existing post harvest practices and equipment which plays an important role in popularizing and making the technology /equipment adopted. Therefore, this study was conducted to assess losses incurred in post-harvest operation and to suggest measures for minimizing the losses.

MATERIALS AND METHODS

The experiment for the estimation of losses for three varieties of wheat (Sujata, GW - 273 and WH - 147) was conducted in the experimental field of the Faculty of Agricultural Engineering and Department of Plant Breeding and Genetics (National Seed Project), Raipur. In the experiment three methods of harvesting and two methods each for threshing, transportation and cleaning/winnowing were used and their effects were observed on losses. The bundling operation was done manually (Table 1). These operations were performed as per the treatment and losses were assessed using standard methodology (Pandey, 2005). To assess the pre-harvest loss of grains were collected from ten randomly selected one-meter square areas in the test field and their weight was recorded and expressed as percentage. Before mechanical harvesting operation the field was cleaned at the periphery for a width of two meters by means of local sickle to avoid breakage of cutter bar and other parts of reaper before harvesting operation. In case of vertical conveyor reaper/tractor mounted reaper the harvesting loss of wheat was calculated by collecting the shattered grains after harvesting from unit area marked before hand. For this, the pre–harvest shattered grains (if any) were carefully picked up before the actual harvest by reaper. Then the shattered grains were collected carefully from the marked areas and weighed. The average of five replications was taken as the loss of wheat as shattering loss per unit area and the loss was converted into percent loss. In case of sickle harvesting the grains/ ear heads are also fallen and they were collected carefully and followed by threshing/cleaning. The weight was recorded and expressed as percentage. To assess the bundling loss, the harvested crop is heaped followed by tying on a tarpaulin/polyethylene surface to facilitate transportation. The grains fallen on the tarpaulin/polyethylene sheet due to this act was collected and weighed. The percentage loss was calculated with respect to total grain yield transported. In order to assess the loss by manual transportation, the bundles of wheat crop are loosely covered with a polyethylene bag and then it is transported through a distance of 1000 m. The weight of the grains collected from the polyethylene bag after unloading the bundles were used to determine the percentage of transportation loss after bringing the moisture content to the level equal to the threshing and cleaning operation. Similarly the bundles of wheat crop were transported by tractor trolley and losses were recorded. In order to estimate the threshing losses the samples were cleaned manually and moisture content was brought to the moisture at which threshing could be done. For determination of threshing loss four bundles of equal weight were threshed manually by wooden stick with every precaution to make sure that no grain would shatter in the process. Wheat grains retained in the heads after threshing was collected cleaned and weighed. Then known number of bundles was threshed by employing the usual method of threshing. The weight of produce obtained after both threshing method was recorded. Threshing loss was calculated from the difference of these two-grain weights. For determination of threshing loss due to mechanical method four bundles of equal weight were threshed by mechanical thresher with every precaution to make sure that no grain/seed should shatter prior to threshing operation. The grains from grain outlet and straw outlet were collected and weighed. The difference in the weight of grains from grain outlet (mechanical thresher) and traditional method was reported as threshing loss (Anonymous, 2003). The losses and yield of wheat in kg ha^{-1} recorded during the experiment were used for estimation of revenue loss considering the support price (Rs kg^{-1}) of wheat fixed at Government level.

RESULTS AND DISCUSSION

Many of the post harvest operations are accomplished by different methods depending upon the holding size, availability of the facility and economic status of the farmer. Efforts have been made to assess the losses in different prevailing methods of the post harvest operations of wheat. Efforts have also been made to compare the losses in these methods. The result of pre harvest and different post harvest losses of three varieties of wheat seeds are presented in Table 2. It can be seen that the losses at different stages of post harvest operations are not same for all the varieties. The variations in losses have also been noticed with the variation in method of operations.

Table 1: Details of operation wise treatment

No.	Operation	Treatment
1.	Pre-harvest	Manually
2.	Harvesting	Sickle
		Self propelled vertical conveyor reaper (VCR)
		Tractor front mounted reaper (FMR)
3.	Bundling	Manually
4.	Transportation	Manually
		Tractor trolley
5.	Threshing	Manually
		Mechanical thresher
6.	Cleaning/winnowing	Manually
		Winnowing fan

The data indicates that the pre harvest loss varied in the range of 0.38 to 0.72 per cent with an average value of 0.45 per cent. It was found the highest for GW - 273 followed by WH - 147 and Sujata [Fig. 1(A)]. The reasons for these variations in different varieties may be due to (i) character of variety (ii) non-uniform tillage operation (iii) variation in plant population (iv) uneven maturity and (v) uneven drying effect. The data on harvesting shows that the losses due to sickle were the lowest (0.71%) compared to two other methods irrespective of varieties (Table 2). However, the minimum loss was observed in Sujata wheat variety. The wheat variety GW - 273 recorded highest percent of loss (1.07%) irrespective of method of harvesting. The Fig. 1(B) shows that the harvesting losses are on higher side for tractor front mounted reaper compared to others in all the varieties. In the harvesting process due to the sudden stroke of the sickle, speed of reaper and vibration of machine, shattering of the over matured pods take place and fall down. The variation in the per cent loss depends on several factors such as speed of cutting process, method of cutting, crop height, crop condition, character of variety, yield of crop and negligence of the workers. In the present study, the losses were found to be within acceptable limit. However, *Kurmi et al.* (1997) reported that 70 per cent of total losses in grain yield resulted during harvesting. Fig. 1(C) shows that the bundling losses are minimum for Sujata (1.32 %) and maximum for GW - 273 (1.52 %). During the bundling process due to the rough handling of the heaped lots the seeds and pods may be shattered and these comprise of the bundling losses. The bundles were transported to the threshing yard on the same day. However Kurmi *et al.* (1997) reported that bundling loss varied accordingly with the harvesting time and variety.

Table 2: Losses in different varieties of wheat during pre and post harvest operations

No.	Type of Loss	Method of operation	Loss, %			
			Sujata	GW-273	WH- 147	Mean
1.	Pre-harvest	Manually	0.38	0.72	0.55	0.45
2.	Harvesting	Sickle	0.54	0.84	0.76	0.71
		Vertical Conveyor Reaper	0.96	1.15	1.09	1.06
		Tractor Mounted Reaper	1.02	1.21	1.12	1.12
	Average		0.84	1.07	0.99	0.96
3.	Bundling	Manually	1.32	1.52	1.46	1.43
4.	Transport	Manually	1.92	2.08	2.15	2.05
		Tractor trolley	0.43	0.52	0.48	0.47
	Average		1.17	1.30	1.31	1.26
5.	Threshing	Manually	2.54	2.82	2.94	2.76
		Thresher	3.95	4.26	4.13	4.11
	Average		3.24	3.54	3.53	3.43
6.	Cleaning/	Manually	0.63	0.46	0.28	0.45
	Winnowing	Winnowing fan	1.54	1.76	1.24	1.51
	Average		1.08	1.11	0.76	0.98

Table 2 shows the transportation losses occurred due to transportation of bundles by tractor trolley or manually as head load for three varieties of wheat. The data shows that the lowest losses are observed in Sujata (1.17%) followed by GW - 273 (1.30%) and WH - 147 (1.31%) wheat variety irrespective of method of transportation. Fig 1(D) shows that the transportation losses are minimum for Sujata (0.43%) in case of Tractor Trolley and maximum for WH - 147 (2.15%) in case of manually as head load. It was observed that the transportation loss depends on several factors such as mode of transport, moisture content of the crop, condition of the path, distance between field and threshing yard, and speed of transportation. Earlier Kurmi *et al.* (1997) reported that the total loss in grain yield during transportation increased progressively with delay in harvesting.

The results obtained shows that the threshing losses occurred due to threshing of bundles by thresher or manually as hand beating for three varieties of wheat. The lowest values are observed in Sujata (3.24%) followed by WH - 147 (3.53%) and GW - 273 (3.54%)

wheat variety irrespective of method of threshing. The Fig. 1(E) shows that the threshing losses are on higher side in mechanical threshing compared to manual beating in all the varieties. These losses may be due to threshing method and shattering of wheat grain during threshing. The shattering happens normally during feeding of crop material in case of mechanical thresher. The variations in losses vary from season to season and maturity of crop. Anwaruehanque (1989) also reported that threshing loss of paddy varied from season to season.

Table 2 shows the cleaning/winnowing losses of three varieties of wheat. The threshed material obtained from each replication was cleaned separately. The cleaning/winnowing was done by two methods viz. manually with the help of a scoop made of bamboo strip locally known as *supa* in which the mixture of threshed material is allowed to fall from a certain height and by using winnowing fan. The lowest cleaning/winnowing losses are observed in WH - 147 (0.76%) followed by Sujata (1.08%) and GW - 273 (1.11%) irrespective of method of cleaning/winnowing. Fig. 1(F) shows that the cleaning/winnowing losses are minimum for WH - 147 (0.28 %) in case of *supa* and maximum for GW - 273 (1.76 %) in case of winnowing fan. The cleaning loss occur due to uneven size of seeds, smaller seeds were thrown away with the husk because there is very small difference between the specific gravity of small seeds and the husk.

The Fig. 2(A) shows that the total pre and post harvest losses of wheat follows the trend: GW - 273 > WH -147> Sujata. It is clear that the loss in Sujata variety was 8.03 per cent whereas GW - 273 recorded 9.25 per cent. However, on the basis of revenue/economic loss as shown in Fig. 2(B) the wheat variety WH - 147 recorded lowest value (Rs. 1503.36) whereas the GW - 273 remained on top (Rs.1837.60) position. This trend may be due the production data and the different cost of wheat grain per kg basis.

CONCLUSIONS

- The total pre and post harvest loss was in the range of 8.03 to 9.25 per cent for three wheat varieties namely Sujata, GW-273, and WH - 147.
- The harvesting loss was minimum under sickle harvesting followed by vertical conveyor reaper and tractor mounted reaper during wheat harvesting.
- The threshing operation recorded highest loss among all types of pre and post harvest operations of wheat crop.
- The transportation of wheat by manually system recorded highest loss compared to tractor trolley system.

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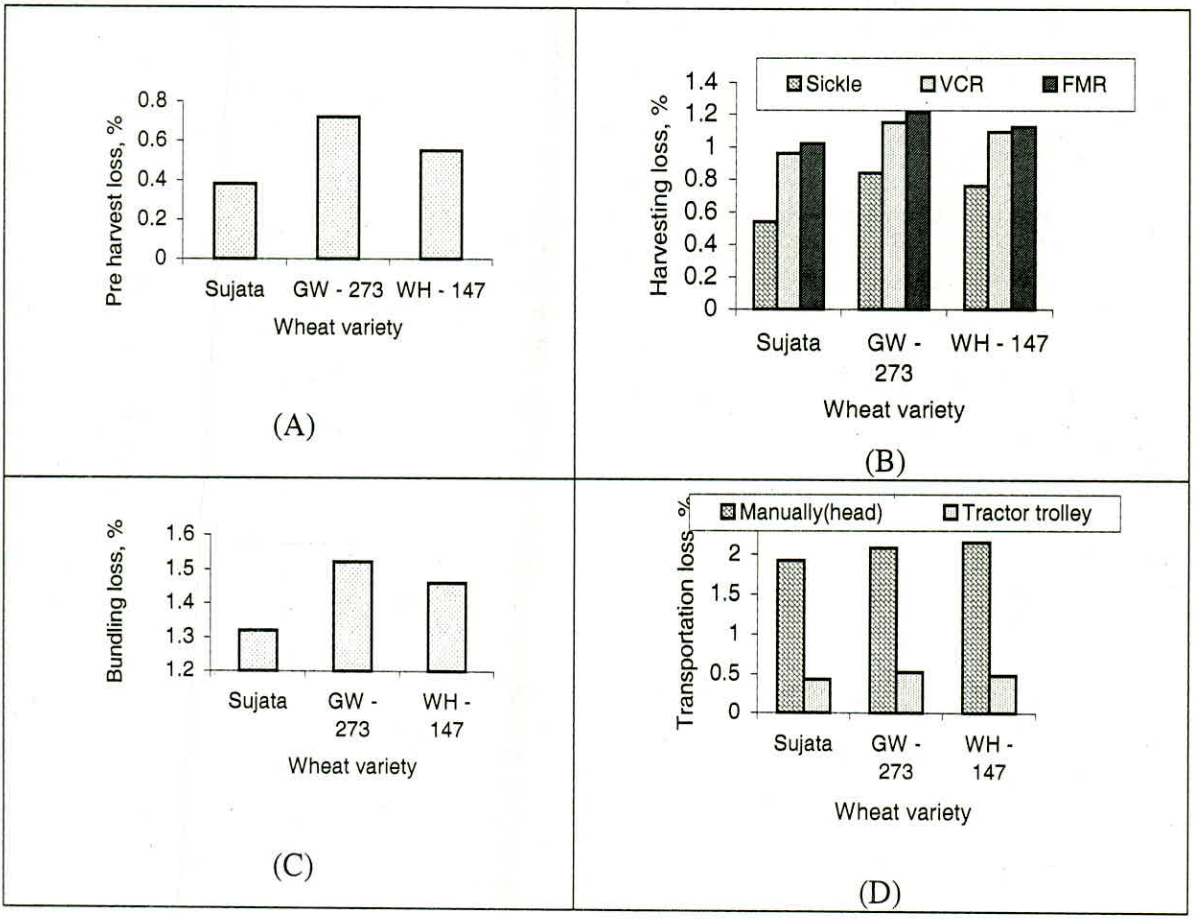


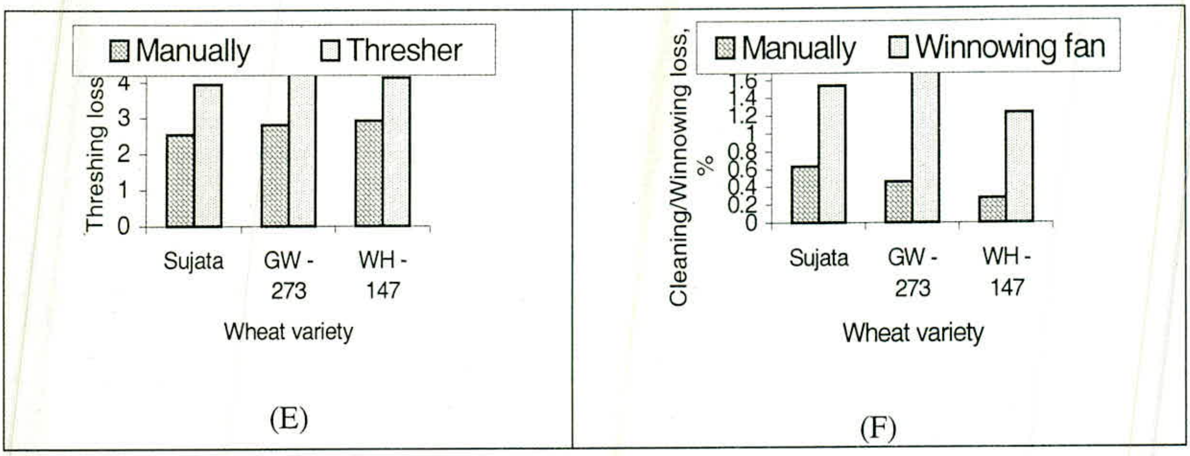
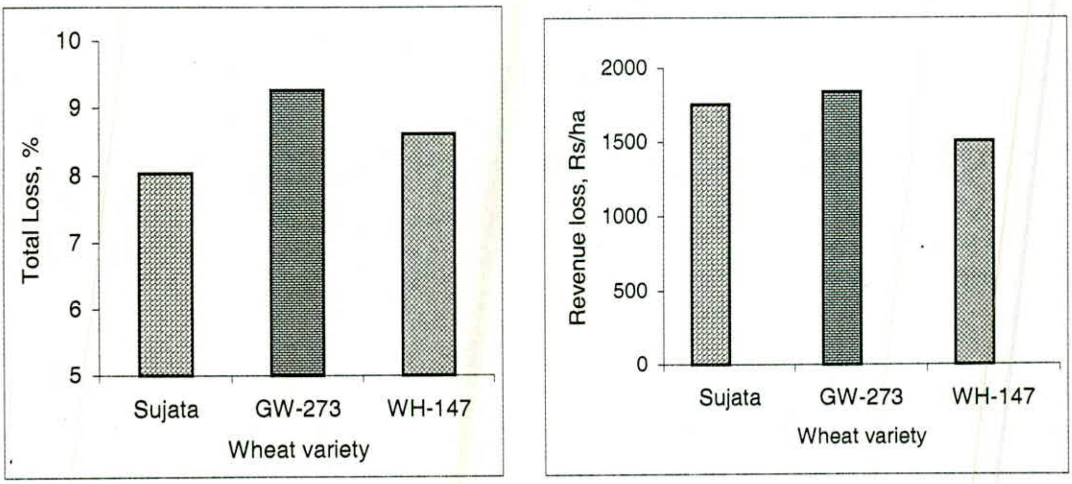


Fig.1: Pattern of pre and post harvest losses in different wheat varieties

(A) Pre harvest loss
(B) Harvesting loss
(C) Bundling loss
(D) Transportation loss
(E) Threshing loss
(F) Cleaning/ Winnowing loss



(A) (B)

Fig.2: Pattern of losses for different wheat varieties in pre and post harvest operations

(A) Total Loss

(B) Revenue loss

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BIOMASS AND NUTRIENT DISTRIBUTION IN FIVE PROMISING CLONES OF *POPULUS DELTOIDES* UNDER SUB-HUMID TROPICS OF CHHATTISGARH

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ABSTRACT

A field experiment was conducted to study the variation in growth, above- and below-ground biomass and nutrient distribution in five promising clones (G3, G48, 65/27, D121 and S7C1) of *Populus deltoides*. Clones were planted at 4 x 4 m spacing in a randomized block design with three replications during 1996. Growth and biomass significantly varied among poplar clones. Diameter and height growth was consistently higher in clone 65/27 and lowest in clone S7C1. Mean annual increments (MAI) in dbh and height at six years age were 1.6 and 1.3 times higher in clone 65/27 compared to clone S7C1. Total biomass varied from 48.5 to 62.2 Mg ha^{-1} in 6-year-old clones. Total biomass in clones was in the order: 65/27 > D121 > G48 > G3 > S7C1. Stem wood accounted 60.4-68.9% to total biomass followed by coarse roots (12.2-18.9%), branches (12.3-15%), leaves (3.02-6.9%) and fine roots (1.5-2.7%). Root-shoot ratio ranged from 0.2 to 0.35. It was highest in clone G48 and lowest in clone S7C1. In 6-year-old clones, total N ranged from 184.3 to 266.3 kg ha^{-1}, P from 16.8 to 31.1 kg ha^{-1} and K from 81.9 to 128.7 kg ha^{-1}. Total N and P were highest in clone 65/27, while K in clone G48. Nutrients were lowest in clone S7C1. Maximum N was allocated to leaves followed by stem, branches, coarse and fine roots. N accumulation in different clones ranged from 31.7.to in 105.3 kg ha^{-1} in leaves, 46.7 to 77.3 kg ha^{-1} in stem, 33.2 to 51.6 kg ha^{-1} in branches , 29.4 to 45.8 kg ha^{-1} in coarse roots and 4.04 to 7.49 kg ha^{-1} in fine roots. In contrast to N, P and K accumulation were highest in stem followed by leaves, branches, coarse and fine roots. Stem wood contribution to total P ranged from 30 to 52%, while for total K from 43 to 61%. The harvest of poplar clones at six years age will drain all the accumulated nutrients if whole trees are harvested. However, a good fraction of these nutrients (40.6-54.9 % N, 30.2-50.2 % P and 27.8–74.1% K) will be returned to the site, if foliage, twigs and root portions are retained in the site and only commercial components (stem and branch) were removed at the harvest. Such management practises will help in minimizing nutrient drain in fast growing poplar plantations.

INTRODUCTION

Environmental degradation and energy crises have prompted a renewed interest in growing short rotation plantations under different land use systems across India. *Populus deltoides* Bartr (Poplar) has emerged as one among the promising fast growing species for plantations. It is native to North America, which was introduced in North India above 28^0 N latitude in 1950s (Khanna et al., 1996). Several promising clones of G series (Australian), D, SC and ST series (American) L and WSL series (India) have been identified and planted extensively in Punjab, Haryana, Tarai region of U.P. and some parts of Bihar, West Bengal and Assam states. Many of these clones are typically managed under 6-8 year rotation cycle. According to a recent estimate, poplar plantations cover almost 60,000 ha and expanding at the rate of 25,000 ha per year (Singh et al., 2001). The average productivity of poplar is 20 to 25 m^3, which is five times higher than traditional forest plantations with native species (Singh et al., 2001). Poplar wood is an important source of plywood, paper pulp and match splint industries. It is also used for manufacturing packing cases, agricultural implements, sports goods and as small timber. Owing to its fast growth rate, high biomass, diverse uses and easy adaptability have prompted to extend the poplar cultivation below 28^0 N latitude. This requires screening for promising clones suitable for lower latitudes. Towards this, an attempt was made to introduce poplar in Chhattisgarh, India (21^0 N latitude) during 1995 (Puri et al., 2002). Preliminary investigations showed that five clones *viz.* G3, G48, 65/27, D121 and S7C1 were found promising and emphasized the need of further evaluation for selecting clones with rapid growth and higher biomass production for large scale operational plantations (Puri et al., 2002).

Biomass production is largely driven by interplay between nutrients and water in plantations. Poplars are prodigious accumulator of nutrients as much as 86 kg N ha^{-1} yr^{-1} had been reported in young plantations (Hansen and Baker, 1979). Patterns of biomass accumulation and nutrient distribution vary considerably within and among poplar clones, indicating that large genetic gains can be made possible by selecting those clones with greater biomass accumulation and lower amount of nutrients in to harvestable components to total biomass. Understanding the biomass and nutrient accumulation will help in evolving suitable strategies of nutrient management for maximizing biomass production in poplar clones. A large amount of nutrients could be lost from the site during harvest of fast growing poplar clones. Selection of appropriate clone and quantifying the biomass, removed from the site will determine the nutrient cost of poplar extraction. Very few attempts were made to understand the biomass and nutrient storage in poplar plantations (Lodhiyal and Singh, 1994), none with respect to nutrient losses either by whole or partial tree harvest in India. Moreover, such studies were not reported from Chhattisgarh. Therefore, the present study was carried out 1) To examine the clonal variation in growth 2) To develop regression models for biomass estimation 3) To study the biomass and nutrients allocation pattern in poplar clones. The study provides useful insights for managing nutrient export from the site at the harvest of poplar clones for firewood/pulpwood.

MATERIALS AND METHODS

The study was conducted at Forestry Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Latitude 21^0 12' N; Longitude 81^0 36' E). Elevation of study site is 290 m above mean sea level. The climate of the study area is sub-humid tropical with an annual rainfall of 1200-1400 mm, of which 80% is received during July to October. Mean monthly minimum and maximum temperatures ranges from 27^0C and 13^0C in December to 42^0C and 28^0C in May, respectively. The soil of study site belongs to V*ertisol* soil type, which is black deep clayey soil with fine texture and sticky in nature. It is fairly rich in organic carbon ($0.43 \pm 0.1\%$) and low to medium in available nutrients (230 kg ha^{-1} N; 300 kg ha^{-1} K; 10.8 kg ha^{-1} P) with a pH of 7.5 ± 0.2 (Puri et al., 2002).

Five promising clones *viz.* 65/27, G3, G48, D121 and S7C1 of *P. deltoides* were planted at 4 x 4 m spacing in a randomized block design with three replications during 1995. Sixteen (16) trees were maintained for a clone in a given replication. Each tree was fertilised with 50 g of single super phosphate (SSP) and 25 g of muriate of potash. Nitrogen in the form of diammonium phosphate (DAP) was given at 100 g $plant^{-1}$ in two split doses (last week of June and September). The fertilization was done initially during the first two years. Plantation was irrigated at weekly in summer (March-June) and fortnightly in winter seasons (October-February). No irrigation was provided during rainy season (July-September) (Puri et al., 2002).

Morphological characters *viz.* diameter at breast height (DBH) and total height were measured in 4, 5 and 6 year-old clones in the 1^{st} week of June during 1999, 2000 and 2001. Stand density of clones was also measured at different years. Similarly, basal area of each clone was computed by multiplying the average cross sectional area of a clone at breast height with its stand density in respective years. Biomass was estimated through regression equations. For developing regression models, seventy five trees corresponding to different DBH (5-30 cm) and height (6-20 m) classes were randomly felled in three blocks. DBH and height of trees were measured before felling. Each tree was subdivided into: stem wood, branches and foliage components. Fresh weights of these components were determined in the field. The components parts were later sub sampled for moisture determination. For analysis of coarse root (> 2 mm diameter) biomass, roots of 25 trees corresponding to 5 clones and 5 diameter classes were excavated by the skeleton method (dry excavation). The soil was dug around trees in 2 m radius up to 1 m soil depth. The remainder of individual roots beyond 2 m radius were also excavated completely. All sub samples were oven dried at 70^0C to a constant weight. The total oven dry weight of each component was calculated by applying oven dry: fresh weight ratio. The regression equations were developed using DBH and height data as independent, while component biomass as dependent variables. Total dry weight of tree parts (foliage, stem, branch and root) were estimated using component wise regression equations. DBH and height data of different years were used for the estimation of standing biomass of clones for the respective years. The individual tree biomass of each clone was summed to obtain plot biomass values and subsequently extrapolated to hectare basis. The foliage, stem and branch biomass were summed to obtain above ground biomass. Later, the above-ground and root biomass were added to derive total biomass. Biomass accumulation was calculated as $\Delta B = (B_2 - B_1 + B_3 - B_2)/2$, where ΔB = biomass accumulation, B_2- standing biomass in 2000, B_1- standing biomass in 1999, B_3 standing biomass in 2001.

Triplicate samples of foliage, bole, branches, coarse roots and fine roots were collected for each clone in different years. The samples were oven dried at 70^0C and ground in a Willey mill to pass through a 2 mm sieve before chemical analysis. The powdered plant material of different components of each clone was analysed for total nitrogen, phosphorous and potassium. N was analysed after digesting the sample in concentrated H_2SO_4 using a catalyst mixture (potassium sulphate and cupric sulphite in ratio 9:1) with a quick digestion unit. The total N was estimated following micro-kjeldhal method (Jackson, 1967). P and K were estimated after digesting the samples in triple acid mixture (HNO_3, H_2SO_4 and $HClO_4$ in 10:1:3 ratios). Total P was determined by vanado-molybdate phosphoric yellow colour procedure and K by flame photometer method (Jackson, 1967). Nutrient quantities in tree components (leaf, branch, stem and root) of each clone were obtained from the products of total biomass of each component and the average nutrient concentrations in that component. The nutrient quantities were extrapolated to hectare basis by multiplying with their standing biomass per hectare.

Data on growth, biomass and nutrients in poplar clones were analysed following randomized block design. Significant difference between treatment means for different parameters were tested at $P \leq 0.05$ using least significant difference (LSD) test. Biomass models were fitted for each component with independent variables dbh and height. A single biomass regression for each component for all the clones was developed using clonal indicator (or "dummy") variable technique (Draper and Smith, 1982). Box-Cox family of transformation (Box and Cox, 1964) characterized by parameter λ was used for model fitting. Model adequacy parameters (P values, % sum of squares of coefficient, R^2, adjusted R^2 and residual mean square Se^2 for overall goodness of fit) were estimated and subjected to statistical tests. The normality assumption and heteroscedacity were thoroughly tested through diagnostic checks. The diagnostics ensured that the residuals follow the basic assumption of normal distribution with zero mean and constant variance approximately (i.e. C, ~ N (O, 6^2). The Box-Cox transformation of responses was fitted against different polynomial combinations of DBH and height parameters. The final models were selected in view of significant estimates of model adequacy parameters apart from rigorous checks through diagnostic plots. Step wise regression procedure (Draper and Smith, 1982) was followed to decide upon the model terms as combinations of basic biomass parameters i.e. DBH and height.

RESULTS AND DISCUSSION

Growth and biomass

Clones exhibited significant ($P \leq 0.05$) variation in different growth parameters (Table 1). However, stand density did not vary significantly among the clones. In 6-year-old clones, stand density varied from 603 to 618 trees ha^{-1}. DBH and height gradually increased with an increase in age of the clones. Between five and six years, DBH increased by 3.9 to 43.1% and total tree height by 3.3 to 26.2% in different clones. DBH and tree height were consistently higher in clone 65/27 and lowest in clone S7C1. In 6th year, mean annual increments (MAI) in DBH and height were 1.6 and 1.3 times higher in clone 65/27 compared to clone S7C1. Clones D121, G48 and G3 did not show any significant differences in DBH and height with clone 65/27 at this age (Table 1). The clonal variations in growth under poplar plantations were observed by many earlier workers (Singh et al., 2001; Puri et al., 2002). Height growth and DBH of five clones tested are comparable to fast growing clones of *P. deltoides* studied elsewhere (Fang et al., 1999). Earlier studies showed that clones G3, G48 and D121 are suitable for growing in north India (Singh et al., 2001). This attributes wider adaptability of these clones as they can be grown in north as well as in central India. Basal area varied from 8.5 to 22.7 m^2 ha^{-1} in 6–year-old clones. The values were within the range and comparable with those reported by Lodhiyal and Singh (1994). Clone 65/27 attained maximum basal area which was 62% higher compared to clone S7C1. The higher basal area in this clone was attained due to higher stand density and greater DBH values.

Biomass equations for all five clones to a given biomass component were prepared using clonal indicator ("dummy") variable technique. The final biomass models for different components (i.e. leaf, stem, branch, root and total) with the transformation parameter (λ) ranging between $-0.025 \leq \lambda \leq 0.35$ are presented in Table 2. The coefficients of the models were very highly significant. Maximum variation was explained in case of total biomass (R^2 = 0.9986, adj R^2 = 0.9984) followed by stem biomass (R^2 = 0.9969, adj R^2 = 0.9963), coarse root biomass (R^2 = 0.9935, adj R^2 = 0.9926) and fine root biomass (R^2 = 0.9711, adj R^2 = 0.9669). Leaf biomass model had minimum variation (R^2 = 0.7996, adj R^2 = 0.7655), however it was sufficient and highly significant. The percentage sum of squares (% SS) explained by each model term revealed that the linear term DBH (i.e. D) alone explained the biomass variation ranging from 85.72 to 97.01% for different components except leaves. It is presumed that when the trees are sampled from the same locality and for the same species, the relationship between DBH and height is very close and inclusion of height does not contribute significantly to regression. Inclusion of height significantly contributed (34%) for improving the precision of biomass estimation only in leaves. The non-linear quadratic term of DBH (i.e. D^2) was responsible for only 0.04% to total biomass (Table 2).

The biomass estimates revealed that all tree components *viz.* leaf, stem, branch, root and total biomass varied significantly ($P \leq 0.05$) in both 5-and 6-year-old clones (Table 3). Biomass in 6-year-old clones varied from 1.8 to 3.9 Mg ha^{-1} in leaves, 33.4 to 40.4 Mg ha^{-1} in stem, 6.14 to 8.64 Mg ha^{-1} in branches, 5.9 to 11.2 Mg ha^{-1} in coarse roots (> 2 mm) and 0.8 to 1.5 Mg ha^{-1} in fine roots (< 2 mm). Total biomass varied from 48.5 to 62.2 Mg ha^{-1} in five clones. The total biomass in different clones followed the order: 65/27 > D121 > G48 > G3 > S7C1. The biomass was lower by 22.1% in clone S7C1 compared to clone 65/27. In 6- year-old clones, root-shoot ratios ranged from 0.2 to 0.35. It was highest in clone G48 and lowest in clone S7C1. Clones D121 and G3 had lower root-shoot ratios compared to clone 65/27 (Table 3). Among tree components, the stem wood accounted for a maximum biomass of 68.9% (Clone S7C1) to 60.4% (Clone G48) of the total, followed by coarse roots (12.2% in clone S7C1 to 18.9% in clone G48), branches (12.3% in clone G48 to 15.0% in clone G3), leaves (3.02% in clone D121 to 6.96% in clone G3) and fine roots (1.5% in clone 65/27 to 2.7% in clone G3) in 6-year-old plantations (Table 3). Comparison of biomass with plantation of similar age indicates that present estimates of biomass are well within the range of biomass values found in poplar plantations studied elsewhere (Fang et al., 1999; Raizada and Shrivastava, 1989). Fang et al. (1999) observed 53.5 to 60 Mg ha^{-1} biomass in 6 yr-old clones of *P. deltoides* planted at density of 500 trees ha^{-1}. In contrary, Lodhiyal and Singh (1994) reported higher biomass ranging from 60 to 108.9 Mg ha^{-1} in 3-and 4-year-old plantations in Tarai region of U.P., India. The higher dbh and height accompanied with more planting density (866 trees ha^{-1}) resulted in higher biomass, whereas low stocking density (600 trees ha^{-1}) and poor dbh growth was responsible for lower biomass production in our study. Moreover, poplar grows profusely in moist and fertile sites of Tarai region of north India, while dry sub-humid and low fertility conditions of the study area had less growth. A strong genotype x environment caused such a variation in poplar clones. The total biomass of clones was in the order of stem > roots > branches > leaves. Similar trend was observed in poplar plantation by several workers (Lodhiyal and Singh, 1994; Puri et al., 2002; Raizada and Shrivastava, 1989). Higher root-shoot ratios in clones G3 and G48 and lower ratios in clones D121 and 65/27 in our study may be attributed to differential allocation pattern of biomass in above-ground to below-ground components. Such clonal variation may not be extraordinary in *P. deltoides* (Heilman and Steltler, 1985). Root-shoot ratios were higher in this study compared to reports of Lodhiyal and Singh (1994). This resulted as a consequence of accounting fine (< 2 mm) root biomass in the total root biomass in our study, which was unaccounted by Lodhiyal and Singh (1994).

Clones varied significantly in biomass accumulation in different components. Between 4-and 6-years, total biomass increased from 14.77 to 18.86 Mg ha^{-1} in different clones and it was highest in clone 65/27 and lowest in clone S7C1 (Table 4). Maximum biomass was accumulated in stem followed by coarse roots, branches, leaves and fine roots. Distribution of total production to stem varied from 57.7 to 70%, to branches from 11.9 to 15.5%, to leaves and twigs from 2.2 to 6.8%, to coarse roots from 9.09 to 21.7% and to fine roots from 1.35 to 1.59% in different clones (Table 4). The biomass productivity (14.7 to 18.8 Mg ha^{-1}) of 6-year-old clones in our study were above the "working minimum" of 10 to 12 Mg ha^{-1} yr^{-1} as proposed by Canell (1989) for fast growing poplar clones. However, our findings on biomass production are comparable to broad range of biomass production (5.9 to 30 Mg ha^{-1} yr^{-1}) in temperate and tropical fast growing poplar plantations (Lodhiyal and Singh, 1994; Fang et al., 1999; Puri et al., 2002). Higher biomass production was achieved in clones 65/27, D121 and G3, which might be presumably due to higher photosynthetic efficiency of these clones compared to clone S7C1.

Nutrient distribution

Clones exhibited significant variation in nutrient (N, P and K) concentrations in different tree components (leaves, stems, branches and roots) (Figs. 1-3), however nutrients did not vary significantly with age of the clones. Among tree components, leaves had highest and stem wood lowest N, P and K concentrations. N and P concentrations were higher in branches than roots. In contrary, K had higher concentration in roots. Clone 65/27 showed highest nitrogen concentration in above ground components (leaves, branches and stem), while clone S7C1 in roots (coarse and fine roots). K concentration was significantly higher in clone 65/27 for leaves, while clone G48 showed highest values for branches and roots (Fig.

3). Nutrient concentrations (N, P and K) in different components of clones were in the order of: leaves > branch > roots > stems, which were almost similar to the reports of Lodhiyal and Singh (1994). Clones exhibited significant variation in nutrient concentrations which reflect the differential requirements of nutrient for their growth and development. A significant and large variation (1.6-2.78%) found in foliar N concentration amongst poplar clones in our study is not extraordinary as previous studies also showed such variation (Lodhiyal and Singh,1994; Singh and Behl, 2001). Singh and Behl (2001) reported 1.6-2.4 per cent of foliage N in G3 and D121 clones of *P. deltoides* .

Total N and P contents were highest in clone 65/27, while K in clone G48 (Table 5). The lowest N, P and K were found in clone S7C1. N and P contents were 1.67 and 1.86 times higher in clone 65/27 and K by 1.57 times greater in clone G48 compared to clone S7C1. In 6-year-old plantation, N accumulation in different clones ranged from 31.7 to 105.3 kg ha^{-1} in leaves, 46.7 to 77.3 kg ha^{-1} in stem, 33.2 to 51.6 kg ha^{-1} in branches, 29.4 to 45.8 kg ha^{-1} in coarse root and 4.04 to 7.49 kg ha^{-1} in fine roots (Table 5). N and P contents were highest in clone 65/27, while lowest in clone S7C1. The total N (leaf + stem + branch + root) ranged from 184.3 to 266.3 kg ha^{-1}. Maximum N was allocated to leaves followed by stem, branches, coarse and fine roots in different clones. Phosphorus storage was lowest among the nutrients studied (Table 5). Total P varied from 16.8 to 31.1 kg ha^{-1} of which stem and leaves together contributed 65-72% in different clones. The phosphorus ratios between root-shoot varied from 0.13 to 0.19. It was highest in clone G3 and lowest in clone 65/27. Unlike N, allocation of P was highest in stem followed by leaves, branches, coarse roots and fine roots. Total K ranged from 81.9 to 128.7 kg ha^{-1}, of which maximum was allocated to stem wood (ranged from 42.8% in clone 65/27 to 61.2% in clone D121). In coarse roots, total K varied from 18.36% in clone 65/27 to 23.4% in clone G3, in leaves from 6.6% in clone D121 to 21.9% in clone 65/27 and in fine roots from 2.1% in clone D121 to 3.4% in clone G3 (Table 5). The standing state of N, P and K in different components of poplar clones are comparable to broad range reported in different poplar clones by Heilman and Stettler (1985). However, the nutrients were much lower compared to hybrid clones of poplars, which were almost 2 to 2.5 times higher at the similar age. The nutrient storage mainly depends on the rate of biomass accumulation and nutrient concentration in different components of poplar clones. In the present study, both nutrient concentrations as well as biomass production were lower and resulted in low nutrient accumulation compared to hybrid poplars.

Nutrient accumulation and export from the site has become an important consideration in fast growing short rotation plantations, where nutrients are removed through frequent harvests (Swamy et al., 2003). Heavy nutrient drain is an adverse impact on long term site quality and sustained production. The harvest of poplar clones at six year age will drain about 184.3 to 266.2 kg ha^{-1} N, 16.7 to 31.1 kg ha^{-1} P and 81.9 to 128.7 kg ha^{-1} K, if whole trees are harvested. Although a major fraction is locked in the bole and branch wood (45.1-59.4 % N, 69.8- 49.8% P and 25.9-72.2 % K), still a good fraction of these nutrients (40.6-54.9 % N, 30.2-50.2 % P and 27.8–74.1% K) will be returned to the site, if foliage, twigs and root portions are retained in the site and only commercial components (stem and branch) were removed at the harvest. Such management practices will help in minimizing nutrient drain in fast growing poplar plantations.

CONCLUSIONS

Several clones of *Populus deltoides* are commonly grown in North Indian states above 28^0 N latitude. However, our study showed that it is possible to grow clones 65/27, D121, G3 and G48 in Chhattisgarh (21^0 N latitude). Clone 65/27 showed consistently superior growth and higher biomass followed by clone D121 and clone G3. Based on growth and biomass clones were ranked in the order: 65/27 > D121 > G48 > G3 > S7C1. The proportional allocation of total biomass to economically harvestable components (stems and branches) and nutrients to non-harvestable components (leaves and roots) were the highest in clones 65/27, G3 and D121. Such allocation pattern will provide higher biomass yields and lower nutrient export from the site at the harvest of poplar, hence preference be given to grow these clones in plantations. Further, it is suggested to retain leaves, twigs, small branches, roots and also debarking of stems and branches should be done before removing the timber from site in order to minimize nutrient losses in poplar plantations.

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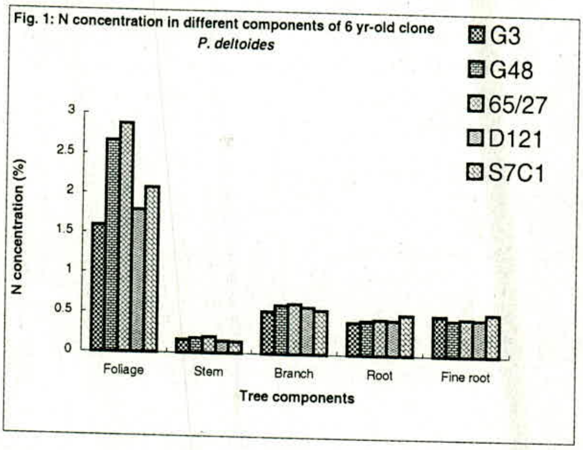

Fig. 1: N concentration in different components of 6 yr-old clone *P. deltoides*

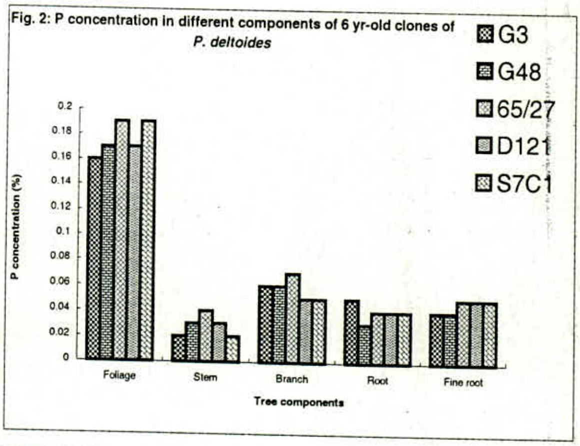

Fig. 2: P concentration in different components of 6 yr-old clones of *P. deltoides*

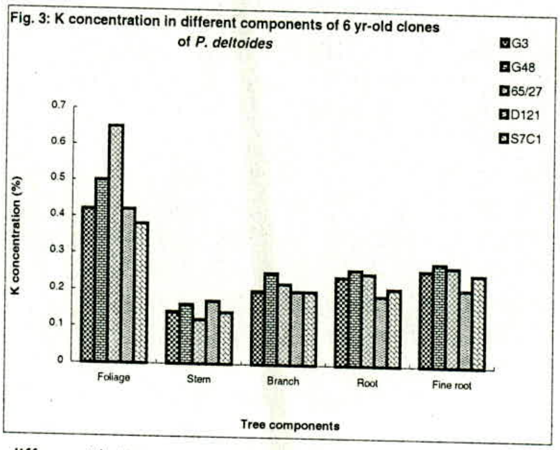

Fig. 3: K concentration in different components of 6 yr-old clones of *P. deltoides*

Note : Means followed by different letters on bar are significant according LSD test

Table 1 : Variation in stand growth and basal area in five clones of *Populus deltoides*

Clone	**Stand density (trees ha^{-1})**			**Mean DBH (cm)**			**Basal area (m^2 ha^{-1})**			**Total height (m)**		
	4th year	**5th year**	**6th year**	**4th year**	**5th year**	**6th year**	**4th year**	**5th year**	**6th year**	**4th year**	**5th year**	**6th year**
G3	608	602	603	11.5	14.6	19.3	6.3	10.1	17.6	9.9	10.9	13.6
G48	611	608	605	11.8	16.1	19.7	6.7	12.4	18.4	10.7	12	14.5
65/27	623	620	618	12.4	15.1	21.6	7.5	11.1	22.7	12.1	13.1	14.3
D121	621	618	616	12	14.7	20.1	7.0	10.5	19.6	8.9	10.3	13.0
S7C1	620	616	614	10.7	12.8	13.3	5.6	7.9	8.5	10.5	10.8	11.16
LSD ($P \leq 0.05$)	**NS**	**NS**	**NS**	**NS**	**0.06**	**3.57**	**NS**	**1.9**	**3.1**	**0.17**	**0.1**	**1.85**

Note LSD- Least significant difference , NS-Non significant

Table 2 : Regression models for biomass estimation of different components of *Populus deltoides*

Biomass Compo-nent	Form of the Model*	Coeff SE, P-val (%SS)	Model coefficient estimates along with their standard errors (SE) and P-values and percentage sum of squares explained (% SS)								Overall model adequacy parameter estimates		
			a (coeff of C1)	b (coeff of C2)	c (coeff of C3)	D (coeff of C4)	e (coeff of C5)	G (coeff of D)	h (coeff of D^2)	i (Coeff of H)	R^2	Adj. R^2	Residual SE (df)# [s_e^2 (df)]
Leaf	Y_1=a*C1+b*C2+ c*C3+d*C4+ g*D+h*H	Coeff	-1.87093	-2.53774	-2.73015	-2.45705	-1.36953	0.04776	-	0.14961	0.7996	0.7655	0.4553 (47)
		P-value	-5.647	-7.662	-10.595	-9.146	-3.482	2.034	-	4.588			
		% SS	36.54					8.976	-	34.43			
Stem	Y_2=a*C1+b*C2+ c*C3+d*C4+ e*C5+ g*D+h*H	Coeff	-0.18893	-0.22739	-0.37498	0.35698	-1.31048	0.31409	-	0.10388	0.9969	0.9963	0.4007 (47)
		P-value	-0.648	-0.780	-1.654	1.510	-3.785	15.201	-	3.620			
		% SS	94.054					5.544	-	8.715			
Branch	Y_3=a*C1+b*C2+ c*C3+d*C4+ e*C5+ g*D+h*H	Coeff	-0.85113	-0.90596	-0.82955	-0.58722	-0.81558	0.11184	-	0.03953	0.9675	0.9619	0.3326 (47)
		P-value	-1.146	1.092	1.772	1.303	-2.981	6.522	-	1.660			
		% SS	85.723					10.832	-	0.190			
Root coarse	Y_4=a*C1+b*C2+ c*C3+d*C4+ e*C5+ g*D	Coeff	-0.29346	0.27438	0.34476	0.26264	-0.90996	0.22943	-	-	0.9935	0.9926	0.3548 (48)
		P-value	-1.146	1.092	1.772	1.303	-2.981	20.067	-	-			
		% SS	85.723					5.44	-	-			
Fine root	Y_5=a*C1+b*C2+ c*C3+d*C4+ e*C5+ g*D	Coeff	-1.426603	-1.284685	-0.950920	-1.434166	-1.391691	0.103321	-	-	0.9711	0.9669	0.1285 (48)
		P-value	-15.38	-14.11	-13.49	-19.64	-12.58	24.95	-	-			
		% SS	59.620					37.488					
Total	Y_6=a*C1+b*C2+ c*C3+d*C4+ e*C5+ g*D+h*D^2	Coeff	0.7533160	0.8691695	0.8483786	1.1110643	0.3766344	0.3187117	-0.003512	-	0.9986	0.9984	0.2109 (47)
		P-value	2.960	3.618	3.770	4.675	1.433	10.573	-3.640	-			
		% SS	97.010					2.814	0.0384	-			

Note : * : $Y_1 = (L^{\lambda}-1)/\lambda$, L=Leaf Biomass (kg), λ=-0.35, λ = Parameter of the Box-Cox transformation for Leaf Biomass. $Y_2 = (S^{\lambda}-1)/\lambda$, S=Stem Biomass (kg), λ=0.25, λ = Parameter of the Box-Cox transformation for Stem Biomass. $Y_3 = (B^{\lambda}-1)/\lambda$, B=Branch Biomass (kg), λ=-0.025, λ = Parameter of the Box-Cox transformation for Branch Biomass. $Y_4 = (R^{\lambda}-1)/\lambda$, CR=Coarse Root Biomass (kg), λ=0.325, λ = Parameter of the Box-Cox transformation for Coarse Root Biomass. $Y_5 = (R^{\lambda}-1)/\lambda$, FR=Fine Root Biomass (kg), λ=0.35, λ = Parameter of the Box-Cox transformation for Fine Root Biomass. $Y_6 = (T^{\lambda}-1)/\lambda$, T=Total Biomass (kg), λ=0.1, λ = Parameter of the Box-Cox transformation for Total Biomass. D=Diameter at breast height (cm)., h = Height of the tree (m), ε = Residual component of the model. C1= Clone D121, C2 = Clone 65/27, C3 = Clone G3, C4 = Clone G48, C5 = Clone S7C1. # : The values in parenthesis are the degrees of freedom corresponding to the overall estimate of the standard error of the model (i.e. df of s_e^2).

Table 3: Variation in standing biomass (Mg ha^{-1}) in five clones of *Populus deltoides*

Clone	Leaves & Twigs			Stem			Branch			Coarse root			Fine root			Total		
	4th year	5th year	6th year	4th year	5th year	6th year	4th year	5th year	6th year	4th year	5th year	6th year	4th year	5th year	6th year	4th year	5th year	6th year
G3	2.4	2.8	3.9	11.3	17.9	34.3	2.92	4.24	8.42	5.0	7.1	7.9	0.8	1.0	1.5	22.4	33.1	56.02
G48	1.9	2.3	3.6	16.2	22.4	34.9	3.92	6.67	7.10	5.5	7.2	10.9	0.6	0.81	1.2	28.1	38.7	57.70
65/27	2.0	2.9	3.7	16.7	30.1	38.7	4.26	4.52	8.64	3.7	6.2	11.2	0.5	0.8	0.9	27.1	44.5	62.24
D121	1.2	1.5	1.8	13.2	18.8	40.4	3.01	4.02	8.43	3.9	5.3	8.9	0.5	0.7	1.1	21.8	31.1	59.50
S7C1	1.4	1.6	2.3	12.9	17.3	33.4	2.65	3.30	6.14	2.5	3.3	5.9	0.3	0.5	0.8	19.8	26.0	48.50
LSD ($P \leq 0.05$)	**0.42**	**0.03**	**0.46**	**3.9**	**0.17**	**4.2**	**1.3**	**0.22**	**13.2**	**0.8**	**0.05**	**1.35**	**0.1**	**0.1**	**0.14**	**4.1**	**6.4**	**8.22**

Table 4 : Biomass accumulation* (Mg ha^{-1} yr^{-1}) pattern in five clones of *Populus deltoides*

Clone	Stem	Branch	Leaves and twigs	Coarse root	Fine root	Total production
G3	11.3	2.62	0.97	1.54	0.5	16.93
G48	9.56	2.04	1.07	3.6	0.3	16.57
65/27	11.10	2.26	1.28	3.82	0.4	18.86
D121	13.1	2.52	0.41	2.46	0.3	18.79
S7C1	10.41	1.82	0.53	1.81	0.2	14.77
LSD ($P \leq 0.05$)	**1.2**	**6.5**	**0.35**	**0.9**	**NS**	**11.1**

Note LSD- Least significant difference , Coarse roots (> 2 mm diameter), Fine roots (< 2 mm diameter) ;* -Biomass accumulation between 4 and 6 years

Table 5 : Nutrient (N, P and K) contents (kg ha^{-1}) in different components of 6-yr-old clones of *Populus deltoides*

Clone	Leaves and twigs			Stem			Branch			Coarse root			Fine root			Total		
	N	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
G3	62.5	6.29	16.52	58.19	7.27	50.92	43.82	5.06	16.85	44.90	5.61	26.94	7.49	0.61	3.97	216.9	24.83	115.2
G48	95.80	6.12	18.01	64.70	10.78	57.52	51.62	5.16	21.51	45.81	3.27	28.35	5.20	0.47	3.31	257.9	25.8	128.7
65/27	105.29	6.97	23.84	77.37	15.47	46.42	44.12	4.98	15.66	35.06	3.18	19.92	4.43	0.48	2.60	266.2	31.1	108.44
D121	31.67	3.00	7.43	60.59	12.12	68.67	48.89	4.21	16.86	38.31	3.56	16.93	4.87	0.54	2.27	184.33	23.43	112.16
S7C1	46.50	4.26	8.54	46.75	6.67	46.75	33.21	3.08	12.30	29.48	2.35	12.38	4.04	0.39	1.94	159.48	16.75	81.91
LSD ($P \leq 0.05$)	**7.89**	**0.788**	**2.23**	**6.87**	**1.22**	**6.38**	**5.19**	**0.51**	**1.94**	**5.79**	**0.50**	**3.23**	**0.67**	**0.06**	**0.37**	**61.5**	**7.15**	**31.3**

Note : ; LSD- Least significant difference , Coarse roots (> 2 mm diameter), Fine roots (< 2 mm diameter)

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A STUDY ON ECONOMIC EFFICIENCY OF RESOURCES IN PRODUCTION OF RICE UNDER IRRIGATED AND RAINFED SITUATIONS OF CHHATTISGARH

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ABSTRACT

The finding of the study envisaged that production efficiency of fertilizer in irrigated rice influenced the gross income by 10.31 per cent with 1 per cent increase on fertilizer cost. Family labour cost affected adversely to gross income of irrigated rice by (-) 5.98 per cent with 1 per cent increase on family labour cost. The production efficiency of fertilizer in rainfed rice was 1 per cent increase on fertilizer, tractor hours, family labour and seed costs, the gross income of rice was increased significantly by 3.32, 1.47, 5.56 and 29 per cent, respectively. The study also indicates that most of the resources were excessively or uneconomically used in irrigated rice, causing declining return to scale (-0.1570), whereas diminishing return to scale (0.4153) was operating in rainfed rice. The optimum use of resources in production of rice revealid that none of the factors were equal to unity in both the situations which indicated that resources were used in rice production either excessively or too scanty. These findings further supported by analyzing the costs and returns in rice production. It reveals that difference in cost was Rs. 611 while difference in net return was Rs.354. The cost on materials and labour inputs were comparatively higher in production of rice than rainfed rice while profitability was marginally higher in irrigated rice. The cost benefit ratio was Rs. 1.19 and Rs. 1.27 in irrigated and rainfed rice which indicates that negligible amount of profit was obtained by the farmers in production of rice in both the situations.

INTRODUCTION

Chhattisgarh is basically dominated by mono-cropped rainfed rice production system. Rice is grown in 3.8 million hectares in the state with an average productivity of 1.3 t ha^{-1}, which is perhaps one of the lowest in the country. The number of factors contributed to low productivity of rice like physical, biological and socio-economical factors. Lack of irrigation infrastructure facilities in the state is most crucial. At present, irrigation provided in a million hectare, contributing only 26.3 per cent to the cropped area. Canal irrigation contributes more than 70 per cent area. Incidentally, the difference between net and gross irrigated area was negligible, indicating the availability of irrigation facility only for *kharif* season. In view of the above, the present study was planned to examine the resource used efficiency in rice production under irrigated and rainfed situations of Chhattisgarh. The objectives of the present study includes to estimate the production efficiency of resources in production of rice under irrigated and rainfed situations; to examine the optimum resource used in production of rice and to evaluate the inputs use and their costs and return.

METHODOLOGY

A sample of 202 farmers was selected by using stratified random sampling technique. In the initial stage, Raipur and Bastar districts were selected to represent the agro-climatic zones of the Chhattisgarh state. From each district, a cluster of 4 villages from 2 blocks was considered. Totally, a cluster of 8 villages and 4 blocks was selected for the study. Rice is the major crop in *kharif* and negligible area in other crops due to lack of sustainable sources of irrigation. Farmers have access to irrigation to some extent by natural water bodies like canal, tank, reservoir, nala etc. From each cluster, 10 per cent farmers for irrigated and rainfed rice farming situations were taken, irrespective to the farm size. From the total of 202 farmers, 26 and 176 farmers were selected for irrigated and rainfed rice farming situations. The data was collected on relevant aspects for year 2002 through survey method, to measure and compare the resources and use efficiency in production of rice under irrigated and rainfed farming situations.

Analytical Tool

The Cobb-Douglas production function was used for estimation of resource use efficiency on per hectare basis and their productivity. A separate functional analysis was done to estimated the production of rice under irrigated and rainfed situations. Before, applying the functional analysis multi-collinearity was tested.

The functional form of Cobb-Douglas production function is as follows:

$$Y = a\, x_1^{b1}\, x_2^{b2}\, x_3^{b3}\, x_4^{b4}\, x_5^{b5}\, x_6^{b6}\, x_7^{b7}\, x_8^{b8}\, e^{u}$$

Where,

Y = Gross return of main and by-product of rice (in Rs./ha)

a = intercept

x_1 = Value of family labour days (in Rs./ha)

x_2 = Value of hired labour days (in Rs./ha)

x_3 = Value of seed (in Rs./ha)

x_4 = Value of fertilizers (in Rs./ha)

x_5 = Value of manure (in Rs./ha)

x_6 = Value of machine hours (in Rs./ha)

x_7 = Value of bullock pairs (in Rs./ha)

x_8 = Value of irrigation (in Rs./ha)

The marginal value productivity (MVPx) of each resource was worked out as:

$$MVPxi = bi \; \frac{\text{Geometric mean of Y}}{\text{Geometric mean of xi}}$$

Where,

bi = regression co-efficient of i^{th} independent variables

The estimated MVPxi was compared with marginal cost (MC) for optimum resource use in production of rice.

RESULTS AND DISCUSSION

Cropping pattern and cropping intensity of sample farms

A general insight in the cropping pattern and cropping intensity of sample farms under irrigated and rainfed-farming situations provides overall picture of the study area (Table 1). It reveals that farm size of irrigated farms were significantly higher than that of rainfed farms and found to be 4.24 and 1.46 hectares, respectively. Rice occupied the highest cropped area in both the farming situations but comparatively less area was planted in irrigated situation than rainfed situation. It was accounted to be 68.88 and 77.30 per cent, respectively. Area under other *kharif* crops (greengram, pigeonpea, soybean, sesame, kodo, maize, ragi, kulthi, madia and chikma) was very marginal which was noticed to be 3.44 and 2.53 per cent in irrigated and rainfed farming situations. The practice of fallowing cultivated land was common phenomena, particularly in *rabi* season. It was due to sources of irrigation were conventional type, like canals, natural reservoirs, tanks, nala etc, which provides only life saving irrigation to the crops subjected to availability of good monsoon. Area under *kharif* fallow was 27.68 per cent in irrigated situations, which increased up to 72.39 per cent in *rabi* season. However, it was 20.17 per cent in *kharif* and increased up to 79.92 per cent in *rabi* under rainfed farming situation. The single factor of fallowing the cropped area was affect to cropping intensity. It was at minimum level and found to be 126.60 and 120.08 per cent under irrigated and rainfed situations.

Table 1: Cropping pattern and cropping intensity of sample farms. (in percent)

Particulars		**Farming situations**	
		Irrigated	**Rainfed**
No. of farmers		**26**	**176**
Average farm size (in ha)		**4.24**	**1.46**
A. Kharif			
	Kharif fallow	**27.68**	**20.17**
	Rice	68.88	77.30
	Other kharif crops*	3.44	2.53
Sub Total		72.32	79.83
B. Rabi			
	Rabi fallow	**72.39**	**79.92**
	Wheat	5.16	1.38
	Lathyrus	11.32	16.30
	Chickpea	4.01	0.71
	Lentil	2.00	0.87
	Linseed	0.57	-
	Pea	0.57	-
	Mustard	0.14	-
	Vegetables	3.85	0.82
Sub Total		27.61	20.08
Gross Cropped Area (in ha)		139.56	308.56
Cropping Intensity (in %)		**126.60**	**120.08**

* Green-gram, Pigeon pea, Soybean, Sesame, Kodo, Maize, Ragi, Kulthi, Madia & Chikma

The area under *rabi* crops was 27.61 per cent and 20.08 per cent under irrigated and rainfed situations, respectively. *Lathyrus* was grown as relay crop, which was the maximum area in *rabi*. Under irrigated situations, wheat, chickpea, vegetables and linseed were dominant than that of rainfed situation. Thus, rice is the major crop grown in *kharif* season only among the sample farms and Chhattisgarh state as whole.

Production function analysis

The production elasticity of resources for rice in irrigated and rainfed situations is presented in Table 2. In case of irrigated rice, influence of fertilizers to gross income was the maximum. The regression co-efficient was found to be 0.1031, which is highly significant.

Table 2: Results of the estimated regression equation of rice production by farming situations

S. No.	Particulars	Farming situations	
		Irrigated rice	Rainfed rice
1	Intercept (a)	10.4268	6.0651
		(0.2386)	(0.2030)
2	Family labour (x1)	-0.0598*	0.0556**
		(0.0452)	(0.0364)
3	Hired labour (x2)	0.0172	-0.0020
		(0.0273)	(0.0079)
4	Seed (x3)	-0.1979	0.2900*
		(0.9769)	(0.2111)
5	Fertilizers (x4)	0.1031***	0.0332***
		(0.0398)	(0.0098)
6	Manure (x5)	0.0171	-0.0037
		(0.0305)	(0.0071)
7	Tractor hours(x6)	-0.0279	0.0147***
		(0.0301)	(0.0091)
8	Bullock pair days (x7)	-0.0264	0.0276
		(0.0425)	(0.0291)
9	Irrigation	0.0176	-
		(0.0307)	-
10	R2	0.4746	0.1912
11	Degree of freedom	26	176
12	Return to scale	-0.1570	0.4153

Note: Figures in parenthesis is the standard error of respective parameters.
*, ** and *** denotes the significant values at 1%, 5% and 10% probability.

The influence of irrigation was not statistically significant but it could be considered to have influence on the gross income by supporting to improve the response of fertilizer and manure. The hired labour was influencing to gross income positively in irrigated rice but it could not be considered to have influence on the gross income. The production elasticity of family labour was (-) 0.0598, which was significant. It indicates that excessive family labour applied and their productivity was found to be negative. The eight variables included in the functional analysis explained 47.46 per cent of the variation in gross income of irrigated rice as revealed by the co-efficient of multiple-determination (R^2). The return to scale was negative (-0.1570) in irrigated rice production, which indicates that declining return to scale is operating with over utilization of most of the resources like family labour and traditional varieties of rice seed.

The production elasticity of resources for rainfed rice was showing different phenomena as compared to irrigated rice. It reveals that fertilizer, tractor hours, family labour and seed influence to the gross return of rainfed rice and the regression co-efficient was 0.0332, 0.0147, 0.0556 and 0.2900, which were found to be statistically significant. The hired labour and manure were negatively influenced to the gross income of rainfed rice but their contribution was non-significant. Thus, it could not be considered to have influence on the gross income of rice. The contribution of bullock labour was positive and non-significant so, it could not influence to output of rice. The seven variables used in the functional analysis explained 19.12 per cent variability and it can be noticed by co-efficient of determination. The return to scale was 0.4153 in rainfed rice, which indicates diminishing return to scale is operating.

The empirical findings envisaged that family labour, seed, tractor hours, and bullock labour were excessively used in irrigated rice production and their efficiencies were negative while hired labour and manure were found negative efficiency in rainfed rice production. The return to scale was diminishing in rainfed rice while declining return to scale was notice in irrigated rice production. It reveals that resources were not utilizing up to their potential and retarded the gross income of rice production in both the farming situations.

Table 3: Ratios of marginal value productivity of input (MVPx) at factors (FC) for rice.

S. No.	Particulars	Farming situations	
		Irrigated rice	**Rainfed rice**
1	Family labour (x1)	-0.0860	0.0681
2	Hired labour (x2)	0.0279	-0.0040
3	Seed (x3)	-0.2900	0.4194
4	Fertilizers (x4)	0.1848	0.0859
5	Manure (x5)	0.0344	-0.0107
6	Tractor hours(x6)	-0.1048	0.0864
7	Bullock pair days (x7)	-0.0484	0.0421
8	Irrigation	0.1080	-

Resource use efficiency

For the assessment of relative importance of resources (factors) for production of rice, the ratio of marginal value productivity (MVP) to factors cost has been computed, which is presented in Table 3. It has been found that the ratios of MVP of resources to marginal cost (MC) of the factors for production of irrigated rice was less than unity which indicates uneconomical use of all the factors of production. It is, therefore, suggested that it would not be profitable in further increase of these factors. For optimizing the profit in irrigated rice it should be balanced use of hired labour, fertilizer, manure and irrigation to the family labour, seed, tractor hours and bullock pair days.

In case of rainfed rice production, the optimum use of resources was quite similar to the production of irrigated rice. The ratio of MVP to MC of factors was less than unity. The use of factors in production of rice was uneconomical. The factors use in rainfed rice was dissimilar to irrigated rice in the manner of that hired labour and application of manure were excessively use, cause to negative MVP and other factors were uneconomically used the repercussion of that less efficient.

Table 4: Input-wise costs and returns in rice production by farming situations

Particulars	Input Use		Costs & Return (Rs. Ha^{-1})	
	Irrigated	Rainfed	Irrigated	Rainfed
No. of Farmers	26	176	-	-
Yield: Main-product (q ha^{-1})	22.78	20.91	-	-
By-product (q ha^{-1})	26.89	-	-	-
Material Inputs:				
Seed (kg ha^{-1})	109.54	112.28	583.51	597.69
Fertilizer (kg ha^{-1})	-	-	773.17	367.91
N	33.45	31.32	-	-
P	19.37	14.82	-	-
K	3.95	1.15	-	-
Manure (t ha^{-1})	3.18	2.99	317.68	299.41
Insecticide (kg a.i. ha^{-1})	12.38	11.66	9.29	10.14
Power for land preparation :				
Animal (days ha^{-1})	7.17	8.92	399.44	553.41
Tractor (hrs. ha^{-1})	1.39	0.53	279.7	114.77
Fuel for land preparation(ltr.ha^{-1})	2.72	0.64	54.39	12.82
Fuel for irrigation (ltr. ha^{-1})	2.25	0.07	110.73	1.44
Sub-total	-	-	**2527.77**	**1957.6**
Labour Inputs:(days ha^{-1})				
Seed bed preparation	4.10	0.85	102.61	21.33
Land Preparation	5.68	11.38	142.08	284.45
Crop establishment	29.69	6.32	711.43	152.41
Thinning & gap filling	4.75	7.44	118.71	186
Beushening	6.37	11.04	159.14	275.89
Manure application	3.94	5.37	98.42	134.89
Fertilizer application	1.70	2.20	42.47	55.02
Weeding	23.04	30.49	575.91	769.71
Chemical application	0.09	0.10	2.32	2.59
Irrigation	0.68	-	17.03	-
Harvesting	29.06	29.86	726.46	746.54
Threshing	10.89	11.94	272.15	298.62
Sub-total	**119.99**	**116.99**	**2968.73**	**2927.45**
Total cost	-	-	**5496.50**	**4885.05**
Total Return	-	-	**12059.89**	**11094.03**
Net Return	-	-	**6563.39**	**6208.98**
Cost-Benefit Ratio	-	-	**1.19**	**1.27**

Input use and costs and return in rice production

A view about the use of inputs and their costs and return for production of rice by situations are shown in Table 4. It has been observed that cost of material and labour inputs were comparatively higher in production of irrigated rice than that of rainfed rice. But profitability in irrigated rice was marginally higher. The per hectare cost was Rs. 5496 and Rs. 4885 for production of irrigated and rainfed rice. Net return over total cost was found to be Rs. 6563 and 6209 in irrigated and rainfed rice. The difference in cost was Rs. 611 while difference in net return was Rs. 354, it indicates that lower levels of inputs by quality were used by the farmers for production of rice in both the situations and realized low income.

The inadequate and uncertainty of irrigation through conventional sources (canal, reservoir, nala etc.) for irrigated rice while timely availability of monsoon and their distribution are important for rainfed rice. The return per rupee investment was low in production of rice of both the situations and found to be Rs. 1.19 and Rs. 1.27 for production of irrigated and rainfed rice. It could be realized that negligible amount of profit was obtained by the farmers in production of rice irrespective farming situations. It is therefore suggested to policy makers that problems should be identified and rectified for higher level of income in production of rice.

Conclusion

The results of empirical study concluded that rice occupied the highest cropped area, which was accounted 68.88 and 77.30 per cent area among the sample farms of irrigated and rainfed situation, respectively. Other crops in *kharif* and *rabi* seasons were placed negligible area. *rabi fallow* was prominent in both the farming situations caused to poor cropping intensity. The production efficiency of fertilizer in irrigated rice was influenced to the gross income by 10.31 per cent with 1 per cent increase on fertilizer cost. While, family labour cost affected adversely to gross income of irrigated rice by (-) 5.98 per cent with 1 per cent increase on family labour cost. The production efficiency of resource in rainfed rice was quite different. It reveals that 1 per cent increase on fertilizer, tractor hours, family labour and seed costs, the gross income of rice was increased significantly by 3.32, 1.47, 5.56 and 29 per cent, respectively. Other factors of production were non-significant in both the situations. It is evident from the findings that most of the resources were excessively or uneconomically used in irrigated rice causing declining return to scale (-0.1570), whereas, diminishing return to scale (0.4153) was operating in rainfed rice. Under both the situations, resources were not utilizing up to their potential, which retarded the gross income in rice production. The optimum use of resources in production of rice was the ratio of marginal value productivity of resources (factors) at factor cost. It was found that none of the factors equal to unity in both the situations indicates resources were used in rice production either excessively or too scanty. These findings further supported by analyzing the costs and returns in rice production. It reveals that difference in cost was Rs. 611, while difference in net return was Rs.354. The cost on materials and labour inputs were comparatively higher in production of rice than rainfed rice while profitability was marginally higher in irrigated rice. The cost-benefit ratio was Rs. 1.19 and Rs. 1.27 in irrigated and rainfed rice which indicates that negligible amount of profit was obtained by the farmers in production of rice in both the situations.

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SOIL FERTILITY AS INFLUENCED BY CONTINEOUS CROPPING IN RICE UNDER RICE- WHEAT CROPPING SYSTEM

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ABSTRACT

The status of soil nutrients, their depletion and build-up and crop productivity after a fourteen years of intensive cropping under various fertilizer and manurial treatments on typic ustochrept was studied. The treatments included various combinations of N,P,K with and without soil amendments as farm yard manure, green manure and rice straw. After fourteen years (1991 – 2005) of continuous intensive cropping on typic ustochrept under various fertilizer and manurial treatments, the differences in the physico-chemical properties, available N, P and K in surface soil and crop productivity were found to be vary markedly. Application of 50% recommended dose of N, P and K nutrients alongwith 50% N through green manure was found to be helpful in sustaining the yield of rice over the years. The inclusion of green manure in the treatment schedule was noted to improve the organic carbon status and available N, P and K in soil. This seems to be helpful in improving the soil health. The omission of plant nutrients in the fertilizer schedule was noted to cause a continuous depletion in the available N, P and K status of soil. The available N status in soil was found to decrease in all the treatments (except in treatment where 100% NPK was applied) but the decrease was found to be of lower magnitude in farm yard manure and green manure treatments indicating the need to raise the level of N fertilizer application to meet the demand of the crop. Thus, application of integrated use of optimal fertilizer dose with green manure was successful in maintaining high level of rice productivity and in the maintenance and improvement of soil fertility.

INTRODUCTION

Sustained soil productivity for a profitable agriculture involves rotational and multiple cropping with high yielding varieties, application of fertilizers and manures, soil and water management, pest control measures etc., and above all, soil conditions to withstand and favourably support the various intensive agricultural practices. No sooner fertilizers were recognised as the most valuable additive to the soil for raising the crop yield than a realisation also started gaining ground that the effect of their continued use in the long run on soil fertility and productivity would be worth examining on a scientific basis. Permanent plot experiments are considered as a tool for providing valuable information on impact of continuous application of fertilizers with varying combination of nutrients on soil fertility and crop productivity and these can be used for precise monitoring of changes in soil fertility and soil productivity; this helps in solving the complex problems related to soil fertility management. There is an apprehension that the use of chemical fertilizers over years may impair soil fertility. In this context it has become necessary to examine the sustainability of high intensive farming on a long-term basis. The present study was therefore undertaken to investigate impacts of the long-term use of nutrients alone and in combinations and with and without FYM, rice straw and green manure on crop productivity and soil fertility with special emphasis on long term sustainability of high production farming.

MATERIALS AND METHODS

The present study pertains to the All India Coordinated Project on cropping system conducted at IGKV, Raipur (CG) in Permanent plot experiment after harvest of rice 2004. The experiment was laid out in bunded *Inceptisol* with twelve treatments replicated thrice in a randomized block design. The treatments are summarized as below

	Kharif (Rice)	Rabi (Wheat)
T_1	No fertilizer, no organic manure (control)	No fertilizer, no organic manure (control)
T_2	50% RDF through fertilizers (40:30:20)	50% RDF through fertilizers (50:25:15)
T_3	50% RDF through fertilizers (40:30:20)	100% RDF through fertilizers (100:50:30)
T_4	75% RDF through fertilizers (60:45:30)	75% RDF through fertilizers (75:37.5:22.50)
T_5	100% RDF through fertilizers (80:60:40)	100% RDF through fertilizers (100:50:30)
T_6	50% RDF through fertilizers + 50% N through FYM (60:40:30)	100% RDF through fertilizers (100:50:30)
T_7	75% RDF through fertilizers + 25% N through FYM (60:45:30)	75% RDF through fertilizers (75:37.5:22.5)
T_8	50% RDF through fertilizers + 50% N through rice straw (60:40:30)	100% RDF through fertilizers (100:50:30)
T_9	75% RDF through fertilizers + 25% N through rice straw (60:45:30)	75% RDF through fertilizers
T_{10}	50% RDF through fertilizers + 50% N through Green manure (60:40:30)	100% RDF through fertilizers
T_{11}	75% RDF through fertilizers + 25% N through Green manure (60:40:30)	75% RDF through fertilizers
T_{12}	Conventional farmer's practice (50:30:20)	Conventional farmer's practice (60:40:20)

The 100% NPK dose based on initial soil test values were 80, 60 and 40 kg ha^{-1} for rice crop.

RESULTS AND DISCUSSION

The highest pooled average yield of rice (5.85 t ha^{-1}) was obtained with 100% RDF (T_5) followed by 6.06 t ha^{-1} in 50% RDF through fertilizers + 50% N through green manure (T_{10}) and the lowest (2.23 t ha^{-1}) was recorded in control (T_1) (Table-1) . Use of conventional farmers practice increased the rice yield by 116 per cent over control. Use of suboptimal dose i.e. 50% RDF through fertilizers (T_2) had caused 98 per cent increase in rice yield over control followed by 131 and 162 per cent increase due to application of 75% (T_4) and 100% (T_5) RDF through fertilizers. These results indicate that even if a farmer applies 50% of the RDF to rice crop, economic returns can be availed.

Further, the meagre difference in increase in the yield between 50% RDF through fertilizers + 50% N through FYM (155 per cent) and 100% RDF through fertilizer (162 per cent) indicates the superfluousness of optimal and/or RDF apparently because the yields may not be economically sustainable. Use of 50% RDF through fertilizer in conjunction with 50% N through green manure resulted in 172 per cent increase in rice yield over control. Further the pooled yield of rice was 150 per cent increase where 50% RDF through fertilizer applied along with 50% N supplied through rice straw as compared to control. The use of RDF in conjunction with green manure, FYM and rice straw as soil amendments proved to be a better proposition over use of recommended dose indicating the benefits of integrated use of fertilizer, FYM and green manure.

Table 1: Response of yield in permanent plot experiment (1991-2005) in rice

Treatment	**Rice yield (q ha^{-1})**		**Percent response over control (1991-2005)**
	Kharif (2004-05)	**Pooled average (1991-2005)**	
T_1	19.62	22.28	-
T_2	47.91	44.17	98
T_3	52.21	46.78	110
T_4	53.71	51.46	131
T_5	63.00	58.46	162
T_6	57.68	56.88	155
T_7	55.52	55.65	150
T_8	54.24	53.95	142
T_9	57.66	55.29	148
T_{10}	62.10	60.62	172
T_{11}	58.24	59.14	165
T_{12}	48.26	48.04	116
CD (P=0.05)	5.91	2.48	-

ORGANIC CARBON

Soil organic carbon content (Table - 2) which was 5.6 g kg^{-1} in control plot increased in all the treatments and the highest (7.5 g kg^{-1}) was recorded in 50% RDF through fertilizers + 50% N through FYM (T_6). The use of fertilizers alone also helps in increasing the organic carbon content of the soil. The findings are in conformity with *Singh et al.* (1999). The increase in organic carbon content due to use of fertilizers can be attributed to higher contribution of biomass to soil in the form of crop stubbles and residues. However, the difference in the organic carbon content due to application of fertilizers might be the results of differential rate of oxidation of organic matter by microbes (*Trehan*, 1997). Organic carbon plays an important role in maintaining soil health and its increase during the period of experimentation shows that use of fertilizers either alone or in integrates with organics has contributed in improving the soil health. The highest value of organic carbon content i.e. 7.5 g kg^{-1} in 50% RDF through fertilizers in conjunction with 50% N through FYM can be assigned to the annual use of FYM during the period of experimentation. This also indicates that if fertilizer use is integrated with manure, substantial improvement in soil health can be expected.

AVAILABLE NITROGEN

Use of nitrogenous fertilizers over the years increased soil available nitrogen status and the increase was 28 percent (Table-2) in 50% RDF through fertilizer (T_2) . However, when the dose was increased to 100% RDF, the increase ranged from 199 to 265 kg ha^{-1} in treatments T_2, T_3, T_4 and T_5 as compared to 155 kg ha^{-1} in control plots (T_1). Increase in available nitrogen due to graded application of NPK has also been reported by Mandal *et al* (1984). Highest value of 242 kg ha^{-1} of available nitrogen was recorded by integrating the use of RDF with FYM amongst other soil amendments. The increase was 56% over control clearly indicating the benefits accruing from integrated use of fertilizers and manure which is also reflected in yield (Table – 1). These findings are in support with findings of Bharadwaj and Omanwar (1994) who observed that available nitrogen content in soil increased significantly with the use of recommended dose of fertilizers and manure.

Table 2 : Available nutrient and organic carbon status of soil after rice

Treatment	OC (g kg^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1	5.6	155	8.59	241
T_2	6.5	199	21.89	256
T_3	6.4	194	24.11	274
T_4	6.3	206	18.66	259
T_5	7.2	265	28.36	295
T_6	7.5	242	24.83	272
T_7	7.0	231	24.73	262
T_8	7.0	230	20.98	266
T_9	6.8	218	21.03	256
T_{10}	7.2	223	23.51	285
T_{11}	7.0	218	21.58	279
T_{12}	6.8	207	19.27	276
CD (P=0.05)	0.8	31	5.86	27

AVAILABLE PHOSPHORUS

It is an accepted fact that 25% to 30% of applied phosphorus is used by the crops and the rest remain, in soil in different forms. The results of soil available phosphorus also supported this contention as use of fertilizers had resulted in an increase in the available phosphorus status of soil. It was found that increasing the dose to 50% NPK (T_2) over control had resulted in 155 per cent increase. However, when full dose of NPK was applied, the increase ranged from 155 to 230 per cent in treatments 50% RDF, 75% RDF and 100% RDF. It is evident from the data that if NPK fertilizers is applied in alone and/or in combination with FYM, Rice straw and green manure then available phosphorus pool of the soil is exploited as the available phosphorus content in the soil was found to be comparable to that present in control. However, the use of 50% RDF through fertilizers with 50% N through FYM resulted in an increase in available phosphorus content in soil (24.83 kg ha^{-1}) which was comparable with 100% RDF through fertilizers (28.36 kg ha^{-1}). These findings indicate that integrated use of fertilizers with manure could enhance the available P content of soil as build-up of available P matches to that attained by application of recommended dose. The results are in conformity with the findings of Subramanian and Kumarasamy (1989) who attributed the appreciable increase in soil available P contents through the influence of organic manure, which could have enhanced the labile phosphorus in soil by competeting, the cations like Ca, Mg and Al responsible for the fixation of phosphorus. The highest yield was also reflected by increased availability of P in the integrated treatments.

AVAILABLE POTASSIUM

The application of balanced fertilizers (T_2, T_3 T_4, and T_5) along with FYM (T_6 and T_7), rice straw (T_8 and T_9) and green manure (T_{10} and T_{11}) and intensive cropping over the years had resulted in increase in the status of available potash as compared to control. Available potassium content in treatment devoid of NPK fertilizer, 22 per cent lower than the 100% recommended NPK through fertilizer treatment indicating that potassium should be an important ingredient in fertilizer schedule. The application of 50% RDF through fertilizer in conjunction with 50% N through FYM (T_6) showed significantly higher available K content (272 kg ha^{-1}) than control due to the application of muriate of potash and FYM which contained about 60 and 0.15 percent of potassium, respectively.

The above results indicate the significant influence of continuous cropping with fertilizers with green manure, FYM and rice straw application on soil fertility and yield of rice taken in rotation for over 14 years. Although there has been a build-up in organic carbon and in the available of N, P and K status due to continuous application of manure and fertilizer, the highest yield and sustainability in yield could be achieved only by the balanced use of organic and inorganic fertilizers. This finding indicate that application of integrated use of recommended fertilizer dose with green manure was successful in maintaining high level of rice productivity and in the maintenance and improvement of soil fertility.

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J. Agril. Issues Vol. 11 (1): 71-74, 2006 SHORT COMMUNICATION

EFFECT OF MICROBIAL INOCULATION ON CARBON AND NITROGEN CONTENT OF PADDY STRAW DURING ITS DECOMPOSITION

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High C:N ratio containing rice straw was converted into compost by following a two-step composting process. Rice straw was degraded by selected organic matter degrading microbes followed by humification. The extent of degradation was measured in terms of reduction in C:N ratio per cent loss in organic carbon and increase in nitrogen content of the decomposing material. Results indicated variation in effectiveness of microbes in accelerating decomposition of rice straw.

Direct application of rice or other crop residues with wide C:N ratio immobilises the available N, P etc., leading to adverse effect on crop growth during initial periods. To avoid such situation, eco-friendly beneficial microbes can be used as inoculants for quick decomposition of these organic materials. Hence, there is need to evolve appropriate management practices including the use of bio-inoculants to recycle crop residues.

In an open environment, the main route of bio-degradation of crop residues is aerobic which is a complex interaction between the crop residue and the microbes. In the presence of moisture, the indigenous species of cellulolytic microbes activate, secrete hydrolyzing enzymes and break complex organic compounds into simpler carbon chain compounds. The consecutive degradation process yields large number of secondary carbon compounds during utilization of organic matter as food source.

Microorganisms can, therefore, be exploited by employing their degradative potential to degrade and/or utilize organic wastes (Yadav and Subbarao, 1980, Singh and Mukerji, 1989 and Madan, 1997). The present paper deals with the role of microbes in utilization of crop residues through degradative potential.

Rice straw containing organic carbon 48.68% and total nitrogen 0.53%, dried at 70^0C and ground to pass through 1 mm mesh sieve, was used in the present investigation. Organic matter degrading microbes mostly crop beneficial eco-friendly microbes viz. *Trichoderma viride* NC 1 (IIPR-Kanpur), *T.viride* NC 2 (TNAU-Coimbatore), *Aspergillus awamori* (IARI), *Pseudomonas straita* (IARI), *Bacillus polymyxa* (IARI), bacterial local isolates *Azospirillum sp.* OMB-1, OMB-2, OMB-3 and fungal local isolates viz. OMF-1, OMF-2 and OMF-3 were used.

In the first step of composting 5 ml of Czapek-Dox nutrient solution (Raper *et al.* 1949) without dextrose was taken in sterilized Petridishes, to which 5g dried straw was mixed and then inoculated with the twelve (12) different microbes. Plate without inoculum served as control. . Each treatment was replicated thrice. Petridishes were then incubated at 28 ± 1^0C for 30 days. During incubation period, moisture was maintained 100 per cent with sterilized double distilled water .

After 30 days of incubation the content of Petridishes was mixed with dairy sludge (organic carbon 31.08 %, total nitrogen 2.40 %) in the ratio of 2:1 (dry weight basis) and incubated for the next 30 days. Loss of water was compensated weekly through addition of sterilized double distilled water. Organic carbon was determined as described by *Walkley* and *Black* (1934) while total N determined by *Kjeldahl Method* as mentioned by *Jackson* (1967).

Data presented in Table 1 indicated the variations in C:N ratio of paddy straw before and after first step of composting (FSC). No significant differences in the organic carbon of decomposing paddy straw inoculated with different microbes were observed. Decrease in organic carbon was 15.15 per cent more than unioculated control when the substrate was inoculated by *T. viride* NC-2 followed by *T. viride* NC-1 (14.29%) while it was least (4.08%) when inoculated by local bacterial isolate (OMB-3). Isolates of *T. viride* (NC-2 and NC-1) indicated to be effective in mineralisation of organic carbon.

Table 1: Changes in C:N ratio on completion of first step of composting of inoculated rice straw

Inoculants		**Organic carbon (%)**	**Decrease in C (%)**	**Total N (%)**	**Increase in N (%)**	**C:N ratio ***
T1-	Control	46.73	-	0.60	-	77.88
T2-	*T. viride* NC-1	40.05	14.29	0.70	16.66	57.21
T2-	*T. viride* NC-2	39.65	15.15	0.73	21.66	54.31
T4-	OMF-1	42.76	8.50	0.63	5.00	67.87
T5-	OMF-2	40.51	13.31	0.69	15.00	58.71
T6-	OMF-3	42.88	8.23	0.63	5.00	68.06
T7-	Aspergillus awamori	41.24	11.75	0.65	8.33	63.44
T8-	Bacillus polymyxa	40.93	12.41	0.67	11.66	61.08
T9-	Pseudomonas striata	41.48	11.23	0.64	6.67	64.81
T10-	Azospirillum sp.	41.52	11.15	0.64	6.67	64.87
T11-	OMB-1	43.07	7.80	0.62	3.33	69.46
T12-	OMB-2	44.30	5.20	0.61	1.67	72.62
T13-	OMB-3	44.82	4.08	0.61	1.67	73.47
CD (p=0.05)		**NS**		**0.05**		

Initial C:N ratio of the fresh paddy straw : 91.85 *C:N ratio of the decomposing paddy straw after 30 days of incubation i.e. after completion of FSC

Significant increase in per cent nitrogen content of decomposing paddy straw inoculated by different microbes was observed. Nitrogen content was highest (21.66%) when the straw was inoculated with *T. viride* NC-2, followed by *T. viride* NC-1 and local fungal isolate No. OMF-2 with 16.66 % and 15.00 % respectively. However, the increase in N was lowest (1.67 %) when the straw was inoculated by local bacterial isolates OMB-2 and OMB-3. Similar observations were also recorded in other treatment combinations. On completion of FSC, decrease in C:N ratio of paddy straw inoculated *T. viride* NC-2 from 77.88 to 54.31 was recorded. In other treatments, the decrease in C:N ratio varied from 73.47 to 57.21 compared to that of 77.88 in control. Drastic reduction in C:N ratio of the decomposing paddy straw inoculated with *Pleurotus sajor-caju*, reported by *Pathak* (1997) supports the present observations.

The C:N ratio of paddy straw after second step of composting (SSC) is presented in Table-2. The per cent content of organic carbon of decomposing paddy straw differ significantly due to cellulolytic activity of inoculated microbes along with dairy sludge which ranged 31.70 in *T. viride* NC-2 to 41.10 in control. On completion of second step of composting, drastic reduction in organic carbon (%) content over control was estimated, which ranged from 9.73 to 22.87 per cent. The per cent reduction in organic carbon was maximum in the straw inoculated with *T. viride* NC-2 (22.87 %) and *T. viride* NC-1 (20.02 %). During second step of composting, heavy loss in organic carbon might be due to the addition of N rich unsterilized dairy sludge. It might have encouraged faster decomposition of straw. *Yadav* and *Subbarao* (1980) also reported the similar type of findings. Further, these findings are strongly supported by *Hsieh et al.*, 1972. They clearly mentioned that long-duration composting resulted in a fall in organic matter content from 67.8 to 52.2 per cent and short-duration composting resulted in a corresponding fall from 67.1 to 56.5 per cent. C:N ratios fell from 37.6 to 16.9 and from 21.9 to 17.6 during the respective composting processes.

Table 2: Changes in C:N ratio on completion of second step of composting of inoculated rice straw along with dairy sludge

Inoculants		**Organic carbon (%)**	**Decrease in C (%)**	**Total N (%)**	**Increase in N (%)**	**C:N ratio ****
T1-	Control	41.10	-	1.32	-	31.14
T2-	*T. viride* NC-1	32.87	20.02	1.66	25.75	19.80
T3-	*T. viride* NC-2	31.70	22.87	1.75	32.57	18.11
T4-	OMF-1	35.30	14.11	1.50	13.63	23.53
T5-	OMF-2	33.66	18.10	1.63	23.48	20.65
T6-	OMF-3	35.72	13.09	1.45	9.85	24.63
T7-	Aspergillus awamori	34.02	17.23	1.55	17.80	21.95
T8-	Bacillus polymyxa	34.51	16.03	1.58	19.70	21.84
T9-	Pseudomonas striata	34.70	15.57	1.52	15.15	22.82
T10-	Azospirillum sp.	34.94	14.98	1.48	12.12	23.61
T11-	OMB-1	36.12	12.12	1.43	8.33	25.26
T12-	OMB-2	36.85	10.34	1.42	7.58	25.95
T13-	OMB-3	37.10	9.73	1.40	6.06	26.50
CD (p=0.05)		**3.97**		**0.15**		

** C:N ratio of the decomposing paddy straw after 60 days of incubation i.e. after completion of SSC

On completion of second step of incubation, N content of decomposing organic matter ranged between 1.32 to 1.75 per cent. The per cent increase in N content over control was significantly higher (32.57 %) when the straw was inoculated by *T. viride* NC-2 followed by 25.75 per cent N when inoculated by *T. viride* NC-1 and 23.48 per cent when inoculated by OMF-2. However, per cent increase in N content was significantly less (6.06%), when the straw was inoculated by OMB-3. In other treatments too, per cent nitrogen content was substantially increased due to rapid loss of carbon during decomposition, showing the role of microbes along with N rich dairy sludge. The C:N ratio was subsequently lowered which ranged from 31.14 in control to 18.11 in *T. viride* NC-2 inoculated decomposing organic matter. *Mathur et al.*, 1986, mentioned that addition of cellulolytic microbial inoculants not only reduced the composting period but also improved the nutrient values including nitrogen content of compost.

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J. Agril. Issues Vol. 11 (1): 75-78, 2006 SHORT COMMUNICATION

EFFECT OF NUTRIENT MANAGEMENT ON SEMI DWARF, MEDIUM TO LONG SLENDER SCENTED RICE VARIETIES IN ALFISOLS OF CHHATTISGARH

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India is well known for its aromatic rice which are distributed in alsmost all the corners of the country. Of these aromatic rices, "Basmati rice", which is considered to be a nature's gift to the sub-continent. In India, Chhattisgarh state is considered as one of the centres of origin and evolution of rice and is blessed with funds of rice variability (Richharia, 1979). Being endowed with the most favorable climate, the Chhattisgarh state has an excellent geographical centre of diversity particularly rice including scented cultivars. The demand for special purpose aromatic rice has dramatically increased over the past two decades and grain quality has been assuming an increasingly important issues particularly since last decade due to change in the consumer's preference for better quality of rice as a result of changed life style of consumers. The success of production potential and its quality of long slender scented rice depends upon the genetic characteristics of varieties and nutrient management. Of these, nutrient management is manageable. Review on nutrient management aspects in medium to long slender scented rice varieties is lacking for this region, therefore, the present investigation was planned to find out the suitable nutrient requirement of different semidwarf and medium to long slender scented rice varieties in *Alfisols* of Chhattisgarh plains.

The field experiment was conducted at Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur during *kharif* season of 2002 in split-plot design using 3 replications with 5 m x 1.8 m plot size. The experimental site was characterized by low land, well drained *Alfisols* (Dorsa) with, neutral in soil reaction (pH 7.3) and moderate climate during the growing season. The treatment consisted of three semi dwarf scented rice varieties (viz. Indira Sugnadhit Dhan-1, Kasturi and Pusa Basmati) in main plot and five nutrient management including blending of nitrogen (viz.: M_1- 40:40:30 kg N:P_2O_5: K_2O ha^{-1}, M_2- 40:40:30 kg N:P_2O_5: K_2O +N blended with FYM ; M_3- 60:50:40 kg N:P_2O_5: K_2O ha^{-1} ; M_4- 60:50:40 kg N:P_2O_5: K_2O +N blended with FYM ; M_5- 10 t FYM ha^{-1}) in sub-plot . Transplanting was done on 2^{nd} August, 2002 using 25 days old nursery at a 20 x10 cm spacing with 2-3 seedlings hill $^{-1}$. N, P_2O_5 and K_2O were applied through urea, single super phosphate and muriate of potash, respectively. N was applied in three splits as 30:40:30 % at basal, maximum tillering and panicle initiation stage, respectively, in each treatments. In case of blending of nitrogen, with FYM as in M_2 and M_4, the required quantity of urea per plot was thoroughly mixed with air dried fine powdered form of well decomposed FYM (in the ratio of 1:4) and incubated for 72 hours under anaerobic condition, prior to its application at every stages of crop growth. The other agronomic practices were followed as per standard recommendations.

Plant height, being a varietal character, was found to differ significantly. Three varieties (Indira Sugandhit Dhan-1, Kasturi and Pusa Basmati) were classified into semi dwarf statured category. Variety Kasturi registered significantly highest plant height (108.8 cm), panicle length (29.81cm), panicle weight (2.95g) and number of sound grains panicle^{-1} (144.2), while variety Indira Sugandhit Dhan-1 registered significantly higher number of tillers at maximum tillering stage (6.89), panicles plant^{-1} (4.32) and test weight (22.22 g) (Table 1).

Ghosh *et al* (2005) recorded the similar observations. The difference between Kasturi and Pusa Basmati for number of tillers at maximum tillering stage and unsound grains panicle^{-1}, and between Indira Sugandhit Dhan -1 (ISD-1) and Pusa Basmati for plant height, length of panicle and panicle weight were not significant (Table 1). The grain and straw yields, as a complex traits of interaction between yield attributes, showed great differences among the cultivars tested. Indira Sugandhit Dhan-1 recorded significantly maximum grain yield of 4.80 t ha^{-1}, being 13.74% and 27.65% higher than Kasturi and Pusa basmati, respectively mainly due to greater number of tillers at maximum tillering stage, number of panicles plant^{-1}, test weight and less sterility percentage (Table 1&2). Variety ISD-1 recorded significantly higher straw yield than the Kasturi and Pusa Basmati. Harvest index did not influence significantly due to change of variety. These findings are in conformity with *Ghosh et al* (2005).

Table 1: Growth and yield attributes of semi dwarf, medium to long slender scented rice varieties as influenced by nutrient management

Treatment	Tillers plant^{-1} at maximum tillering stage (No.)	Plant height (cm)	Panicles plant^{-1} (No.)	Panicle length (cm)	Panicle weight (g)	Test weight (g)
Variety						
V1-ISD-1 *	6.89	99.0	4.32	23.39	2.42	22.22
V2-Kasturi	5.86	108.8	3.80	29.81	2.95	21.30
V3-Pusa Basmati	5.62	96.2	3.33	26.20	2.39	19.88
SEm +-	0.31	2.6	0.09	1.17	0.07	0.17
CD (P=0.05)	0.92	7.9	0.28	3.48	0.21	0.52
Nutrient management						
M_1 - 40:40:30 kg NPK	5.59	100.0	3.73	24.50	2.32	20.50
M_2 - M1+Nb FYM *	6.06	102.1	3.95	25.88	2.47	21.29
M_3 - 60:50:40 kg NPK	6.21	104.5	4.04	26.73	2.54	21.35
M_4 -M3+Nb FYM *	7.05	107.3	4.23	28.90	2.98	21.81
M_5 -10 t FYM	5.72	98.5	3.50	27.05	2.62	21.34
SEm +-	0.15	0.9	0.06	1.00	0.08	0.13
CD (P=0.05)	0.44	2.8	0.19	3.03	0.23	0.38

* ISD-1 Indira Sugandhit Dhan-1 ; Nb FYM - Nitrogen blended with farm yard manure.

Experimental results further revealed that the grain yield of scented rice varied significantly due to nutrient management. Higher level of nutrients (i.e. 60:50:40 kg N:P_2O_5: K_2O ha^{-1}+Nitrogen blended with FYM) recorded significantly higher grain yield (4.79 t ha^{-1}) of scented rice than rest of the nutrient management practices followed (Table 2). The yield differences between higher level of nutrient and lower level of nutrient with blending (40:40:30 kg N: P_2O_5: K_2O ha^{-1}+Nitrogen blended with FYM) were non-significant. The higher grain yield under higher level of nutrients was contributed due to significantly higher tillers at maximum tillering stage (7.05), panicles plant^{-1} (4.23), length of panicle (28.90 cm), panicle weight (2.98 g), test weight (21.81 g), number of sound grains panicle^{-1} (152.0) and significantly lower sterility percentage (16.68%) than rest of the nutrient management treatments (Table 1&2). This has been supported by the findings of *Kumar et al.* (2001). The differences between M_2 and M_3 (lower level +blending with FYM and higher level without blending) for number of tillers, plant height, number of panicles plant^{-1} and grain yield were non-significant. However, for panicle weight and test weight the differences among M_2,M_3 and M_5 were non-significant (Table1). Lowest number of unsound grains panicle^{-1} and sterility percentage were also recorded with higher level of nutrient application along with blending of nitrogen with FYM.

Table 2: Yield and yield attributes of semi dwarf, medium to long slender scented rice varieties as influenced by nutrient management

Treatment	Sound grains panicle^{-1} (No.)	Unsound grains panicle^{-1} (No.)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Sterility (%)	Harvest Index (%)
Variety						
V1-ISD-1 *	131.2	29.0	4.80	9.38	18.11	0.34
V2-Kasturi	144.2	34.8	4.22	7.05	19.44	0.37
V3-Pusa Basmati	138.0	40.5	3.76	8.20	22.69	0.31
SEm +-	1.4	2.2	0.11	0.31	0.42	0.03
CD (P=0.05)	4.3	6.5	0.32	0.90	1.26	NS
Nutrient management						
M_1 - 40:40:30 kg NPK	127.2	38.2	4.00	7.75	23.10	0.34
M_2 -M1+Nb FYM *	129.5	34.3	4.39	8.33	20.85	0.35
M_3 -60:50:40 kg NPK	137.6	31.9	4.51	9.19	18.72	0.32
M_4 -M3+Nb FYM *	152.0	30.6	4.79	8.90	16.68	0.34
M_5 -10 t FYM	142.3	38.6	3.79	6.91	21.34	0.35
SEm +-	2.6	1.7	0.06	0.20	0.33	0.02
CD (P=0.05)	8.0	5.1	0.17	0.61	0.97	NS

- ISD-1 Indira Sugandhit Dhan-1 ; Nb FYM - Nitrogen blended with farm yard manure.

However, at both the levels of nutrients, blending with FYM gave better response in all above growth, yield and yield contributing characters. Singh *et al.* (2005) also reported that urea blended with FYM in combination with ordinary urea in the ratio of 3:1 performed better in rice. It was also revealed that application of 10 t FYM ha^{-1} (i.e. 45:20:40 kg N:P_2O_5: K_2O ha^{-1}) did not show any positive response on yield and yield attributing characters of medium to long slender scented rice varieties. The results confirm the findings of *Dhiman et al.* (1997) and *Dwivedi* (1997). However, nutrient management treatments, in general, did not bring about any significant changes in harvest index values.

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J. Agril. Issues Vol. 11 (1): 79-82, 2006 **SHORT COMMUNICATION**

EFFECT OF NUTRIENT BLENDING WITH FYM ON PRODUCTIVITY AND ECONOMICS OF HYBRID COTTON- SOYBEAN INTERCROPPING SYSTEM

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Cotton can be successfully grown under upland heavy soils locally known as *bharri* (*Vertisols*). Farmers can definitely get higher return with the intercropping of soybean with cotton. Cotton is a long duration crop, cultivated in widely spaced rows. Its growth habits allow enough time and space for short duration intercrops, which help better utilization of resources and input, leading to increased production. Since cotton required large amount of nutrients, considerable reduction in N and P fertilizer use is possible if these nutrients supplied through chemical fertilizer or augmented with certain auxiliary nutrient generating (bio organic) or nutrient containing (organic) sources known to be economically favorable and environmentaly sound. But this needs verification in the existing agro-climatic situation. In view of the above facts, the present experiment was carried out during *kharif* 2004 at Instructional Farm, IGAU, Raipur. The experimental soil was neutral in reaction (pH 7.24), low in nitrogen (217 kg ha^{-1}), medium in phosphorus (12.86 kg ha^{-1}) and high in potassium (364 kg ha^{-1}). The experiment was laid out in randomized block design with three replications. The treatments consisted of fourteen intercropping treatments in combination with nutrient management (Table 1). In blended treatments, required quantity of urea, single super phosphate and muriate of potash thoroughly mixed with exact quantity of air dried FYM with sprinkling of light water followed by incubation for 48 hours prior to its application."NSC-145 (Bunny)" cultivar of cotton and "JS 335" cultivar of soybean were taken as test crops and sown on June 27, 2004.

Yield of seed cotton increased significantly under sole cotton with 100% RDF followed by C+S (2: 2) + 100% RDF, C+S (2:4) + 100% RDF and C+S (2: 2) + 1 t FYM ha^{-1} + 75% RDF. Although these treatments were at par, but proved significantly superior over others (Table 1). Seeds cotton yield increased with successive increase in level of nutrients and registered the higher value with higher dose of NPK, *i.e.* 100% RDF under sole cotton, it may be due to more availability and efficient use of nutrients. The findings of this study are similar to those obtained by Malewar *et al.* (1999) and Bastia (2000).

Significantly maximum seed yield of soybean (20.94 q ha^{-1}) was recorded under sole soybean with 100% RDF followed by C + S (1:4) + C+S (2:4) + 100 % RDF and C+S (1: 4) + 1 t FYM ha^{-1} + 75% RDF (BL). Although these treatments were at par, but proved significantly superior over others (Table 2). Joshi *et al.* (1994) also reported similar results. Use of 100% RDF in sole soybean gave significantly the highest yield. Greater nutrient availability and dry mater production facilitate the enhancement in yield.

Significantly highest total productivity in terms of soybean equivalent yield of cotton and soybean (49.98 q ha^{-1}) was recorded under C+S (2:4) + 100% RDF, which was closely followed and at par with C +S (2:4) 1t FYM ha^{-1} +75% RDF (BL). This might be due to N-fixation behaviour of soybean and also higher canopy resulting in reduced evaporation, transpiration and thereby increased yields. Whereas, lowest total productivity was recorded under sole soybean with 100% RDF. The LER was the highest (1.64) under the treatment C+S (2:4) + 100% RDF which was significantly superior to all other nutrient blended intercrop combinations, except C+S (2:4) + 1t FYM ha^{-1} +75% RDF(BL), which was found to be at par with C+S (2:4) + 100% RDF. Similar trend was noted in case of income equivalent ratio, based on gross income of the crops. Moreover, all the treatments with intercrop combinations proved superior over sole crop with regards to LER and IER (Table 1). These suggest that all the intercropping pattern of cotton and soybean had an advantage over sole crop. *Padhi et al.* (1988) and *Bhuva et al.* (1995) also had similar submission. The maximum monetary advantage (Rs. 12525 ha^{-1}) under C+S (2:4) + 100% RDF was due to higher yield of component crops and also due to less competition among component crops.

Table 1: Yield, total productivity and competition function of hybrid cotton-soybean intercropping system as affected by different treatments

Treatment	Cotton		Soybean		Cotton equiv-alent yield (q ha^{-1})	Total Produ Ctivity (q ha^{-1})	LER	Income equiv-alent yield	Monetory advantage
	Seed cotton yield (q ha^{-1})	Stalk yield (q ha^{-1})	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})					
T_1-Sole cotton (C) + 100% RDF (100:60:40 kg N: P_2O_5: K_2O ha^{-1})	10.07	15.63	-	-	10.07	17.72	1.00	1.00	-
T_2- Sole soybean (S)+100% RDF (30:60:40 kg N:P_2O_5: K_2O ha^{-1})	-	-	20.94	26.27	11.89	41.88	1.00	1.00	-
T_3- C+S (2:2) + 100 % RDF	8.14	13.56	15.30	21.21	16.83	44.93	1.54	1.54	10363
T_4- C+S (2:2) + 1 t FYM ha^{-1} + 75% RDF (Blended)	7.80	13.12	14.87	20.80	16.24	43.46	1.48	1.48	9327
T_5- C+S (2:2) + 2 t FYM ha^{-1} + 50% RDF (Blended)	6.87	12.19	13.76	19.72	14.68	39.61	1.34	1.34	6545
T_6- C+S (2:2) + 2 t FYM ha^{-1} + 50% RDF (Blended) + 0.5 t FYM ha^{-1} with urea (top dressing)	7.08	12.22	13.98	19.88	15.02	40.43	1.37	1.37	7141
T_7- C+S (2:4) + 100 % RDF	7.90	13.26	18.04	24.15	18.15	49.98	1.65	1.65	12525
T_8- C+S (2:4) + 1 t FYM ha^{-1} + 75% RDF (Blended)	7.62	12.99	17.50	23.88	17.56	48.42	1.59	1.59	11482
T_9- C+S (2:4) + 2 t FYM ha^{-1} + 50% RDF (Blended)	6.68	11.98	16.14	22.38	15.85	44.04	1.43	1.43	8429
T_{10}- C+S (2:4) + 2 t FYM ha^{-1} + 50% RDF (Blended) + 0.5 t FYM ha^{-1} with urea (top dressing)	6.92	12.10	16.38	22.60	16.22	43.94	1.47	1.47	9118
T_{11}- C+S (1:4) + 100 % RDF	5.08	10.50	18.34	24.35	15.50	45.62	1.38	1.38	7498
T_{12}- C+S (1:4) + 2 t FYM ha^{-1} + 75% RDF (Blended)	4.84	10.14	17.83	13.91	14.97	44.18	1.33	1.33	6552

T_{13}- C+S (1:4) + 2 t FYM ha^{-1} + 50% RDF (Blended)	3.97	9.46	16.53	22.66	13.36	40.04	1.18	1.18	3638
T_{14}- C+S (1:4) + 2 t FYM ha^{-1} + 50% RDF (Blended) + 0.5 t FYM ha^{-1} with urea (top dressing)	4.16	9.69	16.80	22.85	13.70	40.90	1.22	1.22	4268
SEm±	0.15	0.63	0.25	0.27	0.22	0.64	0.02	0.02	-
CD at 5%	0.45	1.85	0.73	0.79	0.06	1.88	0.06	0.06	-

RDF-Recommended dose of fertilizer, FYM -Farm yard manure

Table 2: Economics of hybrid cotton - soybean intercropping as affected by different treatments

Treatment	Cost of cultivation (Rs ha^{-1})	Gross realization (Rs ha^{-1})	Net realization (Rs ha^{-1})	Benefit :cost ratio
T_1	8319	18505	10186	1.22
T_2	6654	22254	15599	2.34
T_3	7413	31365	23952	3.23
T_4	7406	30294	22888	3.09
T_5	7399	27447	20047	2.70
T_6	7649	28046	20396	2.66
T_7	7412	33814	26402	3.56
T_8	7406	32755	25348	3.42
T_9	7399	29615	22215	3.00
T_{10}	7649	30294	22644	2.96
T_{11}	7412	29023	21611	2.91
T_{12}	7406	28051	20645	2.78
T_{13}	7399	25123	17723	2.39
T_{14}	7649	25749	18099	2.36

Price of produce	Seed	Stalk
Cotton	@Rs 1760 q-1	@Rs 50 q-1
Soybean	@Rs 1000 q-1	@ Rs 50 q-1

Results of economic analysis reveal that the highest gross realization, net realization and B:C ratio was noticed under C+S (2:4) + 100% RDF, which excelled over all other intercropping treatments (Table 2). Similar results were obtained by *Singh* (1996). This is due to higher total productivity under this treatment. Similar results were also noted by *Rajput et al.* (1989), *Prasad* and *Vishwakarma* (1996) and *Itnal et al.* (1994).

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J. Agril. Issues Vol. 11 ( ): 83-86, 2006 **SHORT COMMUNICATION**

EFFECT OF AGRO-RESOURCE MANAGEMENT ON NITROGEN AND ZINC CONCENTRATION IN PLANT, GRAIN YIELD AND QUALITY OF HYBRID RICE DURING SUMMER

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The heterosis in rice hybrid enhances the productivity over inbred varieties, but acceptance by consumer is primarily determined by grain milling quality, appearance, and eating qualities and the aroma of cooked rice. *Jennings et al.* (1979) have advocated to give more emphasis on head rice recovery percentage than total milled rice yield, while judging the suitability of a variety as it is a primary parameter for export purpose and consumer acceptability. The inputs supplied to obtain potential yield and acceptable quality are in prime importance because qualities of both the parents are expected to appear in F1. Moreover, research information available from China, where rice hybrids have been under commercial cultivation, indicated considerable differences in management strategies adopted between hybrids and conventional cultivar (Zhende, 1988). Hence, experiment was undertaken to assess the grain yield and quality of rice hybrid under different agro resource management practices.

A field study was carried out during summer season of 1999 at the Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The soil of the experimental field was clay loam with pH of 6.8 and having organic carbon 0.52 percent. The available nitrogen, phosphorus and potassium content in the soil were 235, 23 and 308 kg ha^{-1}, respectively. The 10 treatments were laid out in randomized block design with 3 replications. Ten treatments were 150:75:60 kg N:P:K ha^{-1} (N_{150} P_{70} K_{60}) ; 200:100:80 kg N:P:K ha^{-1} (N_{200} P_{100} K_{80}); 200:100:80 kg N:P:K ha^{-1} (K 60 % as basal (B) + 40% at maximum tillering (MT) stage) ; 150:75:60 kg N:P:K ha^{-1} (K 60 % as B + 40% at MT stage); 200:100:80 kg N:P:K ha^{-1} + FYM @ 10 tonnes ha^{-1} (FYM $_{10t}$) ; 150:75:60 kg N:P:K ha^{-1} + FYM_{10t} ; 150:75:60 kg N:P:K ha^{-1} + 33% extra plant population (EPP); 150:75:60 kg N:P:K ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} (Zn_{25}) ; 150:75:60 kg N:P:K ha^{-1} N applied as slow release form (SRN) ; 150:75:60 kg N:P:K ha^{-1} + FYM_{10t} + Zn_{25}. The whole amount of P, K and *$ZnSo_4$* was applied as basal dressing, whereas N was applied 40% as basal, 25% at active tillering, 25% at panicle initiation and 10% at flowering. To make N in slow release form (SRN), urea was treated with neem cake powder and kept in shade for 48 hours before the application. The FYM was applied 2 days before transplanting of hybrid rice. One-seedlings of twenty-two days aged of rice hybrid Proagro 6201 was transplanted at a spacing of 20 cm X 15 cm. The N content in plant, grain and straw was determined by micro-Kjeldahl method. The Zn concentration in plant was analyzed by atomic absorption. The hulling, milling, and head rice recovery (HRR) percentage was performed as suggested by Govindaswami and Ghosh, (1969). The cooked kernel length and width was measured using graph papers (Azeez and Shafi, 1966).

The findings revealed that the application of N_{200} P_{100} K_{80} + FYM_{10t} produced the highest grain yield (78.73 q ha^{-1}), which was comparable to those of N_{150} P_{75} K_{60} + FYM_{10t} (76.25 q ha^{-1}) or N_{150} P_{75} K_{60} + FYM_{10t} + Zn_{25} (77.09 q ha^{-1}). The head rice recovery and lengthwise and breadthwise elongation percentage remained comparable under these treatments (Table 1). The continuous release of nutrients for longer period due to FYM enhances the grain yield and quality as also evidenced by Pandey et al. (1999). Nitrogen concentration in plant at different stages and in grain and straw also increased under above treatments indicated the proper supply N helped in increasing the grain yield and quality (Table 2).

Table 1: Effect of integrated agro resource management practices on grain yield and quality of hybrid rice during summer season

Treatment	Grain yield ($q\ ha^{-1}$)	Hulling (%)	Milling (%)	HRR (%)	Lengthwise elongation (%)	Breadthwise elongation (%)	Alkali value
$N_{150}\ P_{75}\ K_{60}$	64.20	76.73	68.64	40.25	41.86	33.90	5.40
$N_{200}\ P_{100}\ K_{80}$	74.81	77.06	68.97	42.37	42.30	37.67	5.40
$N_{200}\ P_{100}\ K_{80}$ (K 60% B : 40% MT)	75.50	78.35	71.03	49.98	45.86	42.93	5.00
$N_{150}\ P_{75}\ K_{60}$ (K 60% B : 40% MT)	68.58	77.19	70.91	47.57	44.39	38.50	5.90
$N_{200}\ P_{100}\ K_{80}$ + FYM_{10t}	78.73	75.25	69.45	51.49	46.30	41.50	6.13
$N_{150}\ P_{75}\ K_{60}$ + FYM_{10t}	76.25	76.46	68.30	50.17	46.10	42.86	5.50
$N_{150}\ P_{75}\ K_{60}$ (33% EPP)	65.94	77.74	68.88	40.10	38.40	35.71	5.10
$N_{150}\ P_{75}\ K_{60}$ + Zn_{25}	67.50	76.19	68.09	42.10	41.13	33.81	4.35
$N_{150}\ P_{75}\ K_{60}$ (SRN)	63.53	77.00	69.17	41.09	40.36	33.53	5.67
$N_{150}\ P_{75}\ K_{60}$ + FYM_{10t} +Zn_{25}	77.09	76.22	68.74	51.15	46.21	41.48	5.10
SEm ±	0.89	0.86	0.82	2.17	1.68	2.43	0.50
CD (P=0.05)	2.63	NS	NS	6.45	5.00	7.23	NS

Moreover, application of K 60% as basal and 40% at MT stage produced the grain quality parameters as good as above treatments. The $N_{150}\ P_{75}\ K_{60}$ (60% as B + 40% at MT) also increased the grain yield to the extent of 6.82% over inorganic nutrient level of $N_{150}\ P_{75}\ K_{60}$, whereas at higher-level ($N_{200}\ P_{100}\ K_{80}$) response of whole amount of K applied as basal or in split was not discernable on grain yield. The maximum tillering and flowering stage of rice is very important for the absorption of K. However, readily available K at maximum tillering stage might have increased the grain yield and quality of hybrid rice. The increase in grain yield due to application of $N_{150}\ P_{75}\ K_{60}$+ Zn_{25} was to the extent of 5.14% over $N_{100}\ P_{60}\ K_{40}$ due to increased Zn concentration in plant at 60 and 90 DAT helped in enhancing the metabolic activity of plant and grain yield, but was unable to favour the grain quality parameters (Table 2). Comparing only inorganic nutrient levels, grain yield and widthwise elongation percent increased with increasing levels from $N_{150}\ P_{75}\ K_{60}$ to $N_{200}\ P_{100}\ K_{80}$ due to increased concentration of nitrogen in plants at all stages and finely in grain and straw. The application of $N_{100}\ P_{60}\ K_{40}$ with 33 % EPP neither increased the grain yield nor quality of grain in hybrid rice.

Table 2: Effect of integrated agro resource management practices on N and Zn content of hybrid rice during summer season

Treatment	N content in plant (%)					Zinc content (ppm)	
	30 DAT	60 DAT	90 DAT	Grain	Straw	60 DAT	90 DAT
$N_{150} P_{75} K_{60}$	2.95	2.36	0.76	1.55	0.44	28.00	12.39
$N_{200} P_{100} K_{80}$	3.20	2.76	0.80	1.68	0.54	32.00	14.00
$N_{200} P_{100} K_{80}$ (K 60% B: 40% MT)	3.21	2.90	0.89	1.69	0.52	40.00	19.00
$N_{150} P_{75} K_{60}$ (K 60% B : 40% MT)	2.90	2.51	0.62	1.51	0.51	38.92	17.70
$N_{200} P_{100} K_{80}$ + FYM_{10t}	3.48	3.20	0.97	1.71	0.57	40.13	19.10
$N_{150} P_{75} K_{60}$ + FYM_{10t}	3.42	3.19	0.95	1.58	0.53	39.33	18.67
$N_{150} P_{75} K_{60}$ (33% EPP)	2.90	2.30	0.63	1.51	0.40	30.00	13.67
$N_{150} P_{75} K_{60}$ + Zn_{25}	3.16	2.91	0.85	1.62	0.49	49.00	22.77
$N_{150} P_{75} K_{60}$ (SRN)	3.10	2.71	0.71	1.57	0.50	39.00	17.73
$N_{150} P_{75} K_{60}$ + FYM_{10t} +Zn_{25}	3.46	3.20	0.93	1.61	0.60	53.50	28.00
SEm ±	0.06	0.03	0.02	0.009	0.01	3.66	2.11
CD (P=0.05)	0.19	0.10	0.06	0.03	0.04	10.88	5.30

In summary, the highest grain yield and quality of hybrid rice may be obtained by applying 150:75:60 kg NPK ha^{-1} along with 10 tonnes of FYM. In absence of FYM inorganic fertilizer of 200:100:80 kg NPK ha^{-1} needs to apply. The application of potassium 60% as basal and 40% at maximum tillering stage increased the grain yield and quality of hybrid rice.

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J. Agril. Issues Vol. 11 (1): 87-89, 2006 **SHORT COMMUNICATION**

INFLUENCE OF NITROGEN AND IRRIGATION SCHEDULES ON GRAIN YIELD AND WATER USE EFFICIENCY OF HYBRID RICE

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The optimum water management plays a significant role in crop growth and grain yield of rice. Although, rice is water-loving plant, possess air channels in cortex of their roots, stems, leaf sheaths and blades for transport of oxygen to the root system. Consequently, they grow well in shallow water, as they are able to transport oxygen efficiently from the shoot to the root system (Ghildyal, 1985). But increasing cost of water renewed the interest of saving irrigation water for rice cultivation. Moreover, in potential rice growing areas, the stagnation or decline in grain yield is often attributed to improper management of water and nutrient particularly nitrogen (Singh *et al.,* 2001). Nitrogen management has a marked impact on nitrogen use efficiency of rice crop. Owing to high grain yield of rice hybrids, utilize water and nitrogen more efficiently as compared to inbred rice. Therefore, study was undertaken to find out effective nitrogen and irrigation schedule for the cultivation of hybrid rice.

The experiments were conducted during rainy season of 1996 and 1997 on silty clay loam soil having the pH of 7.3 and organic matter content of 0.62 %. The available N, P and K of the soil was 248, 21 and 238 kg ha^{-1}. In all, 8 treatments comprising of 2 irrigation schedules and 4 nitrogen levels were laid out in split plot design with three replications. The 2 irrigation schedules i.e. Continuous submergence (5±2cm) and Cyclic submergence were studied as main plot treatments and 4 nitrogen schedules i.e. N 50 % as basal (B) + 50 % at panicle initiation (PI); N 50 % as B + 25 % at PI + 25% at booting; N 25 % as B + 25 % at tillering (T) + 25 % at PI + 25% at booting and placement of total N at 10 days after transplanting (DAT) were studied as subplot treatments. Uniform dose of 150:80:60 kg NPK ha^{-1} was given to the crop during both the years. The whole amount of P and K was applied as basal dressing at the time of planting and nitrogen was applied as per the treatments. Under cyclic submergence saturation was maintained by letting in water before hair crake stage upto 5 cm. The rice hybrid VRH-12 during 1996 and Pro Agro 6201 in 1997 was planted at spacing of 20 x 15 cm.

The significant difference between the two irrigation schedules (cyclic submergence or continuous submergence) on number of panicles, panicle weight and grain yield were not observed during both the years (Table 1). The hybrid rice was grown on heavy soil under low evaporative demand, thus both the irrigation schedules were found to be equally effective for yield components and grain yield. Subbaiah *et al.* (1989) and Pandey *et al.* (1992) reported that continuous submergence throughout crop period is not required, except in very light soils and under condition of high evaporative demand. In general, irrigation and water requirement was the highest under continuous submergence due to frequent irrigations and reduced considerable under cyclic submergence. This irrigation schedule utilized rainfall more effectively during both the years. The water use efficiency was also increased at irrigation schedule of cyclic submergence.

Nitrogen management influenced the grain yield significantly in both the years, but interaction between nitrogen and irrigation schedule were not significant. The placement of whole amount of N at 10 DAT significantly reduced the panicles m^{-2}, panicle weight and grain yield during both the years.

Table 1: Ancillary characters, grain yield and water use efficiency of hybrid rice under different irrigation and nitrogen schedules.

Treatment	Panicles m^{-2} (No)		Panicle weight (g)		Grain yield ($t\ ha^{-1}$)			Irrigation requirement (mm)		Effective rainfall (mm)		Water requirement (mm)		Water use efficiency ($kg\ ha^{-1}\ cm^{-1}$)	
	1996	1997	1996	1997	1996	1997	Mean	1996	1997	1996	1997	1996	1997	1996	1997
Irrigation levels															
Continuous submergence (5±2cm)	362	282	3.41	4.26	7.75	6.26	7.01	783	847	296	273	1079	1120	71.82	55.89
Cyclic submergence	356	285	3.29	4.24	7.60	6.53	7.06	710	710	302	316	1012	1026	75.10	63.65
CD (p=0.05)	NS	NS	NS	NS	NS	NS	-	-	-	-	-	-	-	-	-
Nitrogen schedules															
50 % as B+ 50 % at PI	369	298	3.35	4.36	7.99	6.63	731	746	778	299	294	1045	1073	76.46	61.79
50 % as B+ 25 % PI + 25 at booting	365	293	3.42	4.28	7.92	6.53	7.22	746	778	299	294	1045	1073	75.79	60.85
25 % as B+ 25 % at T+ 25 % at PI + 25% at booting	352	286	3.59	4.32	7.67	6.41	7.04	746	778	299	294	1045	1073	73.40	59.74
Placement of total N at 10 DAT	342	257	3.04	4.03	7.11	5.70	6.40	746	778	299	294	1045	1073	68.04	53.12
CD (p=0.05)	16	9	0.18	0.13	0.34	0.23	0.28	-	-	-	-	-	-	-	-

The application of N, 50 % as basal + 50 % at PI or 50 % as basal + 25 % at PI + 25 % at booting or 25 % as basal + 25 % at tillering + 25 % at PI + 25 % at booting were found to be equally effective for grain yield of rice during both the years due to increased number of panicles and panicle weight. The N supplied under above schedules maintained the capacity of the soil to supply according to N demand of crop which enhanced grain yield components and grain yield. The similar findings have been reported by Venketasawamy *et al.* (1997).

Table 2: Effective rainfall and irrigation and water requirement of hybrid rice under different irrigation schedules (transplanting to maturating)

Treatment	**Irrigation requirement (mm)**		**Effective rainfall (mm)**		**Water requirement (mm)**	
	1996	**1997**	**1996**	**1997**	**1996**	**1997**
Continuous submergence (5±2cm)	283	347	302	273	585	620
Cyclic submergence	210	210	296	316	506	526

600 mm water in used for nursery raising and field preparation

In summary, irrigation schedule of cyclic submergence along with proper incorporation of nitrogen 50 % as basal + 50 % at PI or 50 % as basal + 25 % at PI + 25 % at booting or 25 % as basal + 25 % at tillering + 25 % at PI + 25 % at booting appeared to be suitable option for cultivation of hybrid rice.

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J. Agril. Issues Vol. 11 (1): 91-93, 2006 **SHORT COMMUNICATION**

EFFECT OF NUTRIENT MANAGEMENT ON TALL AND SHORT TO MEDIUM SLENDER SCENTED RICE VARIETIES IN ALFISOLS OF CHHATTISGARH PLAINS

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Chhattisgarh the newly born state of India is known as "rice bowl" which is very popular for the short to medium slender traditional scented rice varieties. These varieties possesses good quality and fetches higher prices in the market. However, these are poor yielder, tall, late maturing and low nutrient responding. As a result of extensive cultivation of high yielding varieties, which are mostly coarse grained, yield has increased, but the farmers are not getting the premium price. Among the various agronomical inputs, fertilizer nutrients are the important through which the yield and quality of scented rice can be improved. Various combinations of organic and inorganic sources of nutrients and methods of these applications have been tried to assess their effect on the high yielding varieties of rice by various scientists and locations during last 3 decades, (Singh and Singh 2003) but very limited attempts have been made to investigate the effect of nutrient management and its blending on medium to long slender scented rice varieties in *alfisol.* Therefore, the present investigation was carried out.

The field experiment was conducted during *kharif* season of 2002 at Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur in split plot design with three replication. The experimental site was characterized by lowland well drained *alfisol* (*Dorsa*) with neutral in soil reaction (pH 7.3) and moderate climate during the growing season. The treatment consisted of three indigenous tall and late maturing of short to medium slender scented rice varieties (viz. Javaphool, Tarun bhog and Dubraj) in main plots and five nutrient management including blending of nitrogen (viz. M_1-25:40:30 kg NPK ha^{-1}; M_2- M_1+N blended with farm yard manures; M_3- 50:50:40 kg NPK ha^{-1}; M_4 M_3+ N blended with FYM, and M5- 10 t FYM ha^{-1}) were tested in sub-plot. Transplanting was done on 3rd August 2002 using 26 days old nursery at a 20x10cm spacing with 2-3 seedlings $hill^{-1}$. Nitrogen, phosphorus and potash were applied through urea, single super phosphate and muriate of potash, respectively. N was applied in three splits as 30, 40 and 30 percent at basal, maximum tillering and panicle initiation stage respectively, in each treatment. In case of blending of nitrogen with FYM as in M_2 and M_4, the required quantity of urea per plot was thoroughly mixed with air dried fine powdered form of well decomposed FYM (in the ratio of 1:4) and incubated for 72 hours under anaerobic condition, prior to its application at every stages of crop growth. The other agronomic practices were followed as per standard recommendations.

In the bunded lowland (*Alfisol*) ecosystem, where the moisture is available for longer time and fertility was slightly better than unbunded uplands, scented rice variety 'Dubraj' recorded significantly maximum grain yield of 3.92 t ha^{-1} being 1.3% and 13.9% higher than Javaphool and Tarun bhog, respectively. However, the difference between Dubraj and Javaphool was non significant (Table 1). Further, the results revealed that number of tillers per plant at maximum tillering stage was significantly higher in Tarun bhog and Javaphool, which were at par, but higher than the Dubraj variety. However, plant height, panicle per plant, length of panicle, number of filled grains per panicle were significantly higher in

Javaphool than Tarun bhog and Dubraj (Table 1). Number of unfilled grain per panicle and harvest index did not influence significantly due to different varieties of rice. Almost similar results were reported by Ghosh *et. al.* (2005). Significantly higher filled grain weight per panicle, test weight, and lower sterility percentage were recorded in Dubraj because of the bold grain size and higher length : breadth ratio compared to Javaphool and Tarun bhog, which contributed to higher yield. These findings are in conformity with Ghosh *et al.* (2005).

Table 1: Growth and yield attribute of short to medium slender scented rice varieties as influenced by nutrient management.

Treatment	No. of tillers plant^{-1} at tillering stage	Plant height (cm)	Panicle plant^{-1} (No)	Panicle length (cm)	Unfilled grain panicle^{-1}	Filled grain panicle^{-1}
Variety						
Java Phool	6.97	155	4.59	28.77	28.6	196
Tarun bhog	7.03	131	4.00	21.00	27.4	176
Dubraj	5.44	127	4.08	20.48	26.5	177
CD 5%	0.66	8	0.28	2.45	NS	16
Nutrient Management						
25:40:30 kg NPK ha^{-1}	6.01	134	3.97	21.93	33.5	164
25:40:30 +Nb FYM *	6.66	140	4.26	22.91	28.6	174
50:50:40 kg NPK ha^{-1}	7.00	142	4.39	23.80	27.0	186
50:50:40 +Nb FYM *	7.13	143	4.56	25.29	21.9	207
10 t FYM/ha	5.60	130	3.95	23.16	26.5	184
CD 5%	0.39	6	0.14	0.97	3.9	13

* NbFYM-Nitrogen blended with farm yard manure at each split application

Table 2: Yield and yield attributes of short to medium slender scented rice varieties as influenced by nutrient management.

Treatment	Panicle weight (g)	Test weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Sterilit y (%)	Harvest index (%)
Variety						
Java Phool	2.51	12.08	3.87	7.57	12.70	0.34
Tarun bhog	2.10	13.10	3.44	9.34	13.38	0.27
Dubraj	2.90	16.30	3.92	8.36	13.02	0.32
CD 5%	0.37	0.28	0.32	1.24	0.34	NS
Nutrient Management						
25:40:30 kg NPK ha^{-1}	2.29	13.56	3.40	7.72	16.66	0.30
25:40:30 +Nb FYM *	2.38	13.76	3.63	8.35	14.01	0.29
50:50:40 kg NPK ha^{-1}	2.48	13.82	4.16	9.66	12.60	0.31
50:50:40 +Nb FYM*	2.81	14.10	4.31	9.40	9.52	0.32
10 t FYM/ha	2.57	13.88	3.23	7.00	12.38	0.31
CD 5%	0.16	0.14	0.28	0.66	1.20	NS

* NbFYM-Nitrogen blended with farm yard manure at each split application

Higher level of nutrients (i.e. 50:50:40 kg NPK ha^{-1}+ Nitrogen blended with FYM at each split application) recorded significantly higher number of tillers per plant, plant height, panicle per plant, length of panicle, number of filled grains per panicle, test weight and grain yield (4.31 t ha^{-1}) than lower level of nutrients (i.e. 25:40:30 kg NPK ha^{-1}) with or without blending with FYM (Table 2). The higher levels of nutrients and blending of N with FYM reduced the losses of applied nutrient and increased the continues supply of nutrients might have resulted in superior growth and yield attributes. Similar findings have been reported by Ram *et al.*(1995) and Dhiman *et al.* (1999). Lowest number of unfilled grain per panicle and sterility percentage were also recorded under above same higher level of nutrients. Both the levels of NPK and blending of nitrogen with FYM proved better in the growth, yield attributing characters and yield of rice (Table 1 and 2). The synergistic effect of blending of nitrogen with FYM in rice was also reported by Kumar *et al.* (2001). However, nutrient management treatments, in general, did not bring about any significant changes in harvest index values. It was also found that application of 10 t FYM ha^{-1}(i.e. 45:20:40 kg NPK ha^{-1}) did not show any positive response on yield and yield attributes of short to medium slender scented rice varieties.

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Table 1: Some important features of small ditch irrigation system at Nardha and Banbarad villages of Durg district, Chhattisgarh. (Average for two years). (Upper-lower Case/ Arial- 10)
The letter size used in table data and description (Upper/lower Case/ Arial- 8/9)

Fig. 1: Rainfall pattern of Chhattisgarh (Upper-lower Case/Arial- 10)
Other description like X & Y axis legend etc. (Upper/lower Case/ Arial- 8/9)

J. Agril. Issues X **(**X**):** XX-XX, **200**X (Upper-lower Case/ Italic-Bold Arial- 10)

ASSESSMENT OF GENETIC VARIABILITY OF RICE GENOTYPES FOR BIOTIC AND ABIOTIC STRESS IN RAINFED ECOSYSTEM (Upper Case/ Bold/ Arial- 11)

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ABSTRACT (Upper Case/ Bold/ Arial- 10)

Humic and fulvic acids extracted from cultivated (rice growing) and adjacent uncultivated (grassland) soils were characterized by elemental composition, functional group determination, and UV and IR spectroscopy. Although there is no marked variation in elemental composition of humic and fulvic acids from different soils, humic and fulvic acids from uncultivated soils contain more total acidity and carboxyl groups. UV spectra of humic and fulvic acids in different soils indicated similar structures, differing only in their intensities. (Text Upper-lower Case/ Arial- 9)

INTRODUCTION (Upper Case/ Bold/ Arial- 10)

Humic and fulvic acids fractions of soil organic matter are highly reactive natural polymeric compounds of varying molecular weights. Marked variation in the elemental and functional group composition have humic and fulvic acids extracted from soils of different climatic and vegetative zones have been reported (Schnitzer, 1977; Ram and Raman, 1981; Dkhar *et al.* 1986). (Text Upper-lower Case/ Arial- 10)

MATERIALS AND METHORDS (Upper Case/ Bold/ Arial- 10)

The characteristics of surface soils (0-0.15 m depth) of both cultivated (paddy growing area) and adjacent uncultivated (grassland) area, used for this study are given in the Table 1. The extraction, fractionation and purification of humic substances were carried out according to the procedure outlined by Kononova (1966) and Schnitzer and Khan (1972). (Text Upper-lower Case/ Arial- 10)

SUBTITLE (Upper Case/ Italic- Bold/ Arial- 10)

Field investigations were conducted for two years (1996-97 to 1997-98) on farmers field of Higna Nala watershed. The watershed is situated 7 km away from Ahiwara towards north of district head quarter Durg, Chhattisgarh. Two villages namely Nardha and Banbarad were selected for the study. (Text Upper-lower Case/ Arial- 10)

Sub-Sub Title: (Upper-lower Case/ Bold/ Arial- 10) Drought at reproductive stage is usual in rice grown during rainy season. The rooting system of rice is inherently incapable of efficiently using moisture from deeper soil layers (Yoshida and Hasegawa 1982). (Text Upper-lower Case/ Arial- 10)

RESULTS AND DISCUSSION (Upper Case/ Bold/ Arial- 10)

The elemental composition of humic and fulvic acid fractions in terms of per cent weight and also in terms of atomic ratios are presented in Table 1. From the data a it is evident that humic acids contained more C than fulvic acids (Table 2). The amount of H in humic acid was higher as compared to fulvic acid while reverse was the case with O. This could be explained by the fact that the formation of fulvic acid accompanied by loss of C and H and gain in (Ortiz de Serra and Schnitzer, 1973; Chellat *et al.* 1985). (Text Upper-lower Case/ Arial- 10)

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Field investigations were conducted for two years (1996-97 to 1997-98) on farmers field of Higna Nala watershed. The watershed is situated 7 km away from Ahiwara towards north of district head quarter Durg, Chhattisgarh. Two villages namely Nardha and Banbarad were selected for the study. (Text Upper-lower Case/ Arial- 10)

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ACKNOWLEDGEMENTS (Upper Case/ Bold/ Arial- 10)

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