Evaluation of Buckwheat Genotypes to Different Planting Geometries and Fertility Levels in Northern Transition Zone of Karnataka

U. K. Hulihalli, Shantveerayya

***Abstract*—**Buckwheat (*Fagopyrum esculentum* Moench) is an annual crop belongs to family Poligonaceae. The cultivated buckwheat species are notable for their exceptional nutritive values. It is an important source of carbohydrates, fibre, macro, and microelements such as K, Ca, Mg, Na and Mn, Zn, Se, and Cu. It also contains rutin, flavonoids, riboflavin, pyridoxine and many amino acids which have beneficial effects on human health, including lowering both blood lipid and sugar levels. Rutin, quercetin and some other polyphenols are potent carcinogens against colon and other cancers. Buckwheat has significant nutritive value and plenty of uses. Cultivation of buckwheat in Sothern part of India is very meager. Hence, a study was planned with an objective to know the performance of buckwheat genotypes to different planting geometries and fertility levels. The field experiment was conducted at Main Agriculture Research Station, University of Agriculture Sciences, Dharwad, India, during 2017 Kharif. The experiment was laid-out in split-plot design with three replications having three planting geometries as main plots, two genotypes as sub plots and three fertility levels as sub-sub plot treatments. The soil of the experimental site was vertisol. The standard procedures are followed to record the observations. The planting geometry of 30*10 cm was recorded significantly higher seed yield (893 kg/ha^{-1}), stover yield (1507 kg ha^{-1}), clusters plant^{-1} (7.4), seeds clusters^{-1} (7.9) and 1000 seed weight (26.1 g) as compared to 40*10 cm and 20*10 cm planting geometries. Between the genotypes, significantly higher seed yield (943 kg ha^{-1}) and harvest index (45.1) was observed with genotype IC-79147 as compared to PRB-1 genotype (687 kg ha^{-1} and 34.2, respectively). However, the genotype PRB-1 recorded significantly higher stover yield (1344 kg ha^{-1}) as compared to genotype IC-79147 (1173 kg ha^{-1}). The genotype IC-79147 was recorded significantly higher clusters plant^{-1} (7.1), seeds clusters^{-1} (7.9) and 1000 seed weight (24.5 g) as compared PRB-1 (5.4, 5.8 and 22.3 g, respectively). Among the fertility levels tried, the fertility level of 60:30 NP kg ha^{-1} recorded significantly higher seed yield (845 kg ha^{-1}) and stover yield (1359 kg ha^{-1}) as compared to 40:20 NP kg ha^{-1} (808 and 1259 kg ha^{-1} respectively) and 20:10 NP kg ha^{-1} (793 and 1144 kg ha^{-1} respectively). Within the treatment combinations, IC 79147 genotype having 30*10 cm planting geometry with 60:30 NP kg ha^{-1} recorded significantly higher seed yield (1070 kg ha^{-1}), clusters plant^{-1} (10.3), seeds clusters^{-1} (9.9) and 1000 seed weight (27.3 g) compared to other treatment combinations.

***Keywords*—**Buckwheat, fertility levels, genotypes, geometry, polyphenols, rutin.

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I. Introduction

BUCKWHEAT (*Fagopyrum esculentum* Moench) is an annual plant of a family *Poligonaceae* [6]. It pronounces as wheat but it does not belong to wheat family. Primary gene of buckwheat origin is from wider area of Central Asia. The name of this species is derived from two words fagus (beech) and pyros (beech and wheat). On global basis it is mainly cultivated in Russia, China, Ukraine, Poland, UAS, Brazil, India and Japan [1]. Its sown area in the world in the last decade is doubled, from a million to over two million hectares. In India, cultivation of buckwheat is very limited, mainly grown in Himalayan ranges of North and Eastern India and Nilagiri and Palani hills of South India [3].

The cultivated plant species of buckwheat is notable by its exceptional nutritive values [4], [5] with comparison to wheat and rice (Table I). In most of the countries, buckwheat is not eaten to satisfy the people's hunger in modern time but it is mainly consumed because of its taste and the human health benefits. Buckwheat has significant content of rutin (quercetin-3-rutinosid) and other polyphenols. The content of rutin is one of the most important polyphenols which play a major role in human health. Rutin, quercetin and some other polyphenols are potent anti-carcinogens against colon and other cancers. The anti-carcinogenic and anti-mutagenic potentials are related to their anti-oxidative property, which is important in the protection against cellular oxidative damage. Phenolic compounds present in buckwheat may lower the blood sugar and lipid levels. It is very rich in trace elements (viz., Zn, Cu, Mn and Se). The starch of buckwheat includes numerous compounds that have been identified to have beneficial effects on human health, including lowering both blood lipid and sugar levels [5], [6]

TABLE I
NUTRITIONAL COMPARISON OF BUCKWHEAT GRAIN WITH WHEAT AND RICE

Nutritional fractions	Buckwheat	Wheat	Rice
Protein (g/100g)	12.5	11.8	6.8
Fat (g/100g)	2.4	1.5	0.5
Energy (kcal)	355	346	345
Fibre (g/100g)	10.3	1.2	0.2
Salt (g/100g)	2.9	1.5	0.7
Calcium (mg/100g)	114	41	10
Lysine (g/100g)	6.2	1.9	1.7
Methionine (g/100g)	1.6	1.5	2.4
Cysteine (g/100g)	1.6	2.2	1.4
Isoleucine (g/100g)	3.7	3.3	3.9
Iron (mg/100g)	13.2	3.5	1.8

The buckwheat is used for human consumption, animal feed as well as for medicinal purpose. It is short duration crop which suits very well for different cropping systems like intercropping, catch cropping, double cropping etc. Since, it covers the land very fast, it can also be used in soil and water conservation practices. Buckwheat is also grown as green manure as well as leafy vegetable. It attracts honey bees; with help of beehives we can harvest 20-30 kg honey from one hectare area. The cultivated area of buckwheat in south India is meager. Karnataka is one of the agriculturally important states of India with no area buckwheat. It has maximum area under minor millets which are also having high nutritional characteristics as well as medicinal properties as that of buckwheat. With all the above facts in view, the experiment was planned to introduce buckwheat cultivation in Karnataka as well as to know the effect of planting geometries and fertility levels on buckwheat genotypes.

II. Material and Methods

To study the influence of planting geometries and fertility levels on buckwheat genotypes, the field experiment was carried out during *kharif* 2017 at Main Agricultural Research Station, Dharwad. The geographical indication of Dharwad is 15^0 30^1 6^{11} North Latitude and $74^0 59^1 12.4^{11}$ East Longitude with an attitude of 678 m above Mean Sea Level. The average annual rainfall of Dharwad is 750 mm. The experiment was laid out in split-plot design having three planting geometries *viz.*, D_1 - 30*10 cm, D_2 - 40*10 cm and D_3 - 20*10 cm as main plots, two genotypes *viz.*, G_1- IC-79147 and G_2- PRB-1 as sub plots and three fertility levels *viz.*, F_1-20:10 N:P kg ha^{-1}, F_2-40:20 N:P kg ha^{-1} and F_3- 60:30 N:P kg ha^{-1}as sub-sub plots with three replications. Soil of the experimental site was vertisols. The standard procedures are followed to record the observations. Leaf Area Index (LAI) was calculated by disc method [8].

III. Results and Discussion

A. Growth parameters

The data on growth parameters viz., plant height at harvest, LAI at peak vegetative period and total dry matter production per plant at harvest as influenced by planting geometries, buckwheat genotypes, fertility levels and their interaction effects are presented in Table II.

Optimum planting geometry depends on soil type, climatic conditions, location of the trial, sowing time and genotypes. Among the planting geometries, 30*10 cm planting geometry recorded significantly higher plant height (89.3 cm), LAI (2.3) and total dry matter production (8.4 g plant^{-1}) as compared to other planting geometries. Between the two genotypes tried, IC-79147 recorded significantly lower plant height (82.5 cm), LAI (1.6) and total dry matter production (6.4 g plant^{-1}) as compared to PRB-1 (92.5 cm, 2.4 and 7.5 g plant $^{-1}$ respectively). Within the fertility levels, the fertility level of 60:30 kg NP ha^{-1} recorded significantly higher plant height (92.5 cm), LAI (2.2) and total dry matter production (7.5 g plant^{-1}) compared to other fertility levels tried. The interaction effect of PRB-1 genotype sown with planting geometry of 30*10 cm having fertility level of 60:30 kg NP ha^{-1} recorded significantly higher plant height (100.4 cm), LAI (3.0) and total dry matter production (9.7 g plant^{-1}) as compared to other interaction effects. A possible reason for increased growth parameters was due to better utilization of environmental resources like moisture, nutrients, sunlight etc., and longer duration of the PRB-1 genotype which matures in 90 days compared to IC 79147 which matures in 65 days.

TABLE II
Effect of Planting Geometries and Fertility Levels on Plant Height, LAI and Total Dry Matter Production of Buckwheat Genotypes

Treatments	Plant height (cm)	LAI	Total dry matter production (g plant^{-1})
Main plot, Planting Geometries (D)			
D_1 - 30 * 10 cm	89.3 ^{a}	2.3 ^{a}	8.4 ^{a}
D_2 - 40 * 10 cm	87.2 ^{b}	1.9 ^{b}	7.0 ^{b}
D_3 - 20 * 10 cm	86.1 ^{b}	1.8 ^{b}	5.5 ^{c}
Sub plot, Genotypes (G)			
G_1 – IC -79147	82.5 ^{b}	1.6 ^{b}	6.4 ^{b}
G_2 – PRB -1	92.5 ^{a}	2.4 ^{a}	7.5 ^{a}
Sub-sub plot, Fertility levels (F) NP kg ha^{-1}			
F_1 - 20:10 NP kg ha^{-1}	84.2 ^{b}	1.8 ^{c}	6.6 ^{b}
F_2 - 40:20 NP kg ha^{-1}	85.8 ^{b}	2.0 ^{b}	6.8 ^{b}
F_3 - 60:30 NP kg ha^{-1}	92.5 ^{a}	2.2 ^{a}	7.5 ^{a}
D X G X F			
D1G1F1	79.6 ^{hi}	1.7 ^{ij}	7.5 $^{c-e}$
D1G1F2	84.2 $^{e-h}$	1.8 ^{hi}	8.1 $^{b-d}$
D1G1F3	87.6 $^{b-e}$	2.1 ^{fg}	8.4 ^{bc}
D1G2F1	91.7 ^{bc}	2.5 ^{cd}	8.5 ^{bc}
D1G2F2	92.4 ^{b}	2.8 ^{ab}	8.6 ^{b}
D1G2F3	100.4 ^{a}	3.0 ^{a}	9.7 ^{a}
D2G1F1	78.5 ^{i}	1.4 ^{k}	6.1 ^{gh}
D2G1F2	82.2 $^{f-i}$	1.4 ^{k}	6.3 $^{f-h}$
D2G1F3	86.2 $^{d-a}$	1.7 ^{ij}	7.0 $^{e-g}$
D2G2F1	90.0 $^{b-d}$	2.3 $^{d-f}$	7.2 $^{d-f}$
D2G2F2	88.1 $^{b-e}$	2.4 $^{c-e}$	7.2 $^{d-f}$
D2G2F3	98.0 ^{a}	2.6 ^{bc}	8.4 ^{bc}
D3G1F1	78.1 ^{i}	1.3 ^{k}	4.6^j
D3G1F2	81.3 $^{g-i}$	1.3 ^{k}	4.9 ^{ij}
D3G1F3	84.9 $^{d-g}$	1.5 ^{jk}	5.3 $^{h-j}$
D3G2F1	87.4 $^{b-e}$	2.0 ^{gh}	5.8 ^{hi}
D3G2F2	86.7 $^{c-f}$	2.2 $^{e-g}$	6.0 ^{gh}
D3G2F3	98.0 ^{a}	2.4 $^{c-e}$	6.3 $^{f-h}$

* Means followed by the same letter(s) within a column are not significantly different by DMRT (P = 0.05)

B. Yield Parameters

The results on yield parameters like clusters plant^{-1}, seeds clusters^{-1} and 1000 seed weight as influenced by planting geometries, buckwheat genotypes, fertility levels and their combinations are depicted in Table III.

Significant differences were observed among the planting geometries with respect to clusters plant^{-1}, seeds clusters^{-1} and 1000 seed weight. The planting geometry of 30*10 cm recorded significantly higher clusters plant^{-1} (7.4), seeds clusters^{-1} (7.9) and 1000 seed weight (26.1 g) as compared to other planting geometries. The genotype IC-79147 recorded significantly higher clusters plant^{-1} (7.1), seeds clusters^{-1} (7.9) and 1000 seed weight (24.5 g) as compared PRB-1 genotype (5.4, 5.8 & 22.3 g respectively). Fertility levels had a significant influence on yield parameters. The higher fertility level of 60:30 NP kg ha^{-1} recorded significantly higher clusters plant^{-1} (7.4), seeds clusters^{-1} (7.8) and 1000 seed weight (24.1 g) as compared to other fertility levels of 40:20 NP kg ha^{-1} (6.1, 7.3 and 23.5 g respectively) and 20:10 NP kg ha^{-1} (5.4, 6.3 and 22.6 g respectively). Among the interaction effects of planting geometry, genotypes and fertility levels, the planting geometry of 30*10 cm with genotype IC-79147 having fertility level of 60:30 NP kg ha^{-1} was recorded significantly higher clusters plant^{-1} (10.3), seeds clusters^{-1} (9.9) and 1000 seed weight (27.3 g) as compared to other treatment combinations. The increase in yield parameters is due to increased growth parameters and genetic potentiality of the genotype.

TABLE III
EFFECT OF PLANTING GEOMETRY AND FERTILITY LEVELS ON CLUSTERS PLANT^{-1}, SEEDS CLUSTER^{-1} AND 1000 SEED WEIGHT OF BUCKWHEAT GENOTYPES

Treatments	Clusters plant $^{-1}$	Seeds cluster^{-1}	1000 seed weight (g)
Main plot, Planting Geometries (D)			
D_1 - 30 * 10 cm	7.4 ^{a}	7.9 ^{a}	26.1 ^{a}
D_2 - 40 * 10 cm	6.3 ^{b}	7.2 ^{a}	23.1 ^{b}
D_3 - 20 * 10 cm	5.1 ^{c}	6.3 ^{b}	21.0 ^{c}
Sub plot, Genotypes (G)			
G_1 – IC -79147	7.1 ^{a}	8.5 ^{a}	24.5 ^{a}
G_2 – PRB -1	5.4 ^{b}	5.8 ^{b}	22.3 ^{b}
Sub-sub plot, Fertility levels (F) NP kg ha^{-1}			
F_1 - 20:10 NP kg ha^{-1}	5.4 ^{b}	6.3 ^{c}	22.6 ^{b}
F_2 - 40:20 NP kg ha^{-1}	6.1 ^{a}	7.3 ^{b}	23.5 ^{a}
F_3 - 60:30 NP kg ha^{-1}	7.4 ^{a}	7.8 ^{a}	24.1 ^{a}
D X G X F			
D1G1F1	7.1 $^{c-e}$	8.3 ^{bc}	26.3 $^{e-c}$
D1G1F2	7.7 ^{bc}	9.8 ^{a}	26.9 ^{ab}
D1G1F3	10.3 ^{a}	9.9 ^{a}	27.3 ^{a}
D1G2F1	5.7 $^{f-i}$	6.0 ^{ef}	24.5 $^{d-f}$
D1G2F2	6.5 $^{c-f}$	6.5 ^{de}	25.4 $^{b-d}$
D1G2F3	7.3 $^{b-d}$	7.2 ^{cd}	26.3 $^{a-c}$
D2G1F1	6.2 $^{b-g}$	7.4 ^{cd}	23.6 $^{e-g}$
D2G1F2	6.6 $^{c-f}$	9.1 ^{ab}	24.6 $^{d-f}$
D2G1F3	8.5 ^{b}	9.1 ^{ab}	25.1 $^{c-e}$
D2G2F1	4.7 $^{h-j}$	5.3 ^{fg}	21.1 $^{i-k}$
D2G2F2	5.8 $^{e-h}$	5.6 $^{e-g}$	21.9 $^{h-j}$
D2G2F3	6.1 $^{d-g}$	6.4 $^{d-f}$	22.5 $^{j-i}$
D3G1F1	5.0 $^{g-i}$	6.4 $^{d-f}$	21.4 ^{ij}
D3G1F2	5.5 $^{f-i}$	8.0 ^{bc}	22.2 $^{g-i}$
D3G1F3	7.1 $^{c-e}$	8.3 ^{bc}	23.1 $^{f-h}$
D3G2F1	3.5 ^{j}	4.6 ^{g}	18.9 ^{l}
D3G2F2	4.4 ^{ij}	4.8 ^{g}	19.7 ^{kl}
D3G2F3	4.9 $^{j-i}$	5.7 $^{e-g}$	20.5 ^{jk}

* Means followed by the same letter(s) within a column are not significantly different by DMRT (P = 0.05)

C. Seed Yield, Stover Yield and Harvest Index

The data on buckwheat seed yield, stover yield and harvest index as influenced by planting geometries, genotypes, fertility levels and their interaction effects are given in Table IV.

Significant differences were observed among the planting geometries. The planting geometry of 30*10 cm recorded significantly higher seed yield (893 kg ha^{-1}) and stover yield (1507 kg ha^{-1}) as compared to other geometries tried, 40*10 cm (816 and 1245 kg ha^{-1} respectively) and 20*10 cm (737 and 1024 kg ha^{-1} respectively) whereas, significantly higher harvest index was observed with 20*10 cm planting geometry compared to other geometries tried. The genotype differed significantly with respect to seed and stover yield as well as harvest index. Significantly higher seed yield (943 kg ha^{-1}) and harvest index (45.1) was observed with genotype IC-79147 as compared to PRB-1 genotype (687 kg ha^{-1} and 34.2 respectively). However, the genotype PRB-1 recorded significantly higher stover yield (1344 kg ha^{-1}) as compared to IC-79147 (1173 kg ha^{-1}). The results of fertility levels indicated the significant differences with seed yield, stover yield and harvest index. The fertility level of 60:30 NP kg ha^{-1} recorded significantly higher seed yield (845 kg ha^{-1}) and stover yield (1359 kg ha^{-1}) as compared to 40:20 NP kg ha^{-1} (808 and 1259 kg ha^{-1} respectively) and 20:10 NP kg ha^{-1} (793 and 1144 kg ha^{-1} respectively) [2]. However, the harvest index was maximum with lower fertility level of 20:10 NP kg ha^{-1} (41.5) as compared to higher fertility level of 60:30 NP kg ha^{-1} (38.3) but it was on par with 40:20 NP kg ha^{-1} (39.2). Among the interaction effects planting geometry of 30*10 cm with IC-79147 genotype having higher fertility level of 60:30 NP kg ha^{-1} recorded significantly higher seed yield (1070 kg ha^{-1}) as compared to other interactions whereas, 30*10 cm planting geometry with PRB-1 genotype having 60:30 NP kg ha^{-1} recorded significantly higher stover yield compared to other combinations. Significantly higher harvest index was observed with interaction effect of 20*10 cm planting geometry having IC-79147 genotype with lower fertility level of 20:10 NP kg ha^{-1} (50.7) compared to other treatment combinations. The increased yield of genotype IC-79147 was mainly due to significant increase in number of clusters plant^{-1} (7.1), seeds clusters^{-1} (7.9) and 1000 seed weight (24.5 g) compared to PRB-1 (Table III) and greater genetic ability of variety to translocate the photosynthates to economic part this was inturn due to higher uptake of nutrients. Genotype PRB-1 recorded significantly higher stover yield (1344 kg ha^{-1}) compared to IC-79147 (1173 kg ha^{-1}) this is due to production of higher biomass per plant as well as longer duration of the genotype (90 days) compared to short duration IC-79147 (65 days).

IV. INTERACTION EFFECTS ON BUCKWHEAT SEED YIELD (KG HA^{-1})

A. Interaction Effects of Planting Geometries and Genotypes

Significant differences with seed yield were observed between the genotypes irrespective of planting geometries (Fig. 1). The genotype IC-79147 had given significantly higher seed yield over all the planting geometries viz., 30*10 cm (1020 kg ha^{-1}), 40*10 cm (940 kg ha^{-1}) and 20*10 cm (870 kg ha^{-1}) as compared to PRB-1 (760, 690 and 610 kg ha^{-1} respectively) whereas, planting geometry of 30*10 cm recorded significantly higher seed yield in both genotypes, IC-

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79147 (1020 kg ha^{-1}) and PRB-1 (760 kg ha^{-1}) compared to 40*10 cm (940 and 690 kg ha^{-1} respectively) and 20*10 cm (870 and 610 kg ha^{-1} respectively). Among the treatment combinations, planting geometry of 30*10 cm with IC- 79147 genotype recorded significantly higher seed yield (1070 kg ha^{-1}) compared to other interactions.

TABLE IV
EFFECT OF PLANTING GEOMETRY AND FERTILITY LEVELS ON GRAIN YIELD, STOVER YIELD AND HARVEST INDEX OF BUCKWHEAT GENOTYPES

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index
Main plot, Planting Geometries (D)			
D_1 - 30 * 10 cm	893 ^{a}	1507 ^{a}	37.4 ^{b}
D_2 - 40 * 10 cm	816 ^{b}	1245 ^{b}	39.6 ^{ab}
D_3 - 20 * 10 cm	737 ^{c}	1024 ^{b}	41.9 ^{a}
Sub plot, Genotypes (G)			
G_1 – IC -79147	943 ^{a}	1173 ^{b}	45.1 ^{a}
G_2 – PRB -1	687 ^{b}	1344 ^{a}	34.2 ^{b}
Sub-sub plot, Fertility levels (F) NP kg ha^{-1}			
F_1 - 20:10 NP kg ha^{-1}	793 ^{b}	1144 ^{c}	41.5 ^{a}
F_2 - 40:20 NP kg ha^{-1}	808 ^{b}	1259 ^{b}	39.2 ^{ab}
F_3 - 60:30 NP kg ha^{-1}	845 ^{a}	1373 ^{a}	38.3 ^{b}
D X G X F			
D1G1F1	973 ^{bc}	1297 $^{c-f}$	43.2 ^{bc}
D1G1F2	1033 ^{ab}	1400 $^{b-e}$	42.5 $^{b-d}$
D1G1F3	1070 ^{a}	1527 $^{a-c}$	41.8 $^{b-d}$
D1G2F1	763 ^{fg}	1507 $^{a-c}$	33.9 $^{e-f}$
D1G2F2	747 ^{g}	1597 ^{ab}	32.1 ^{f}
D1G2F3	770 ^{fg}	1713 ^{a}	31.1 ^{f}
D2G1F1	880 ^{de}	1027 $^{g-i}$	46.2 ^{ab}
D2G1F2	953 ^{c}	1170 $^{e-h}$	45.0 ^{ab}
D2G1F3	980 ^{bc}	1263 $^{c-g}$	43.8 ^{bc}
D2G2F1	707 ^{gh}	1237 $^{d-h}$	36.5 $^{d-f}$
D2G2F2	670 ^{hi}	1333 $^{b-f}$	33.5 ^{ef}
D2G2F3	703 ^{gh}	1440 $^{b-d}$	32.9 ^{ef}
D3G1F1	827 ^{ef}	810 ^{i}	50.7 ^{a}
D3G1F2	863 ^{de}	977 ^{hi}	47.1 ^{ab}
D3G1F3	910 ^{cd}	1090 $^{f-h}$	45.6 ^{ab}
D3G2F1	607 ^{ij}	987 ^{hi}	38.3 $^{c-e}$
D3G2F2	580 ^{i}	1077 $^{f-h}$	35.1 ^{ef}
D3G2F3	637 $^{h-j}$	1207 $^{d-h}$	34.8 ^{ef}

* Means followed by the same letter(s) within a column are not significantly different by DMRT (P = 0.05)

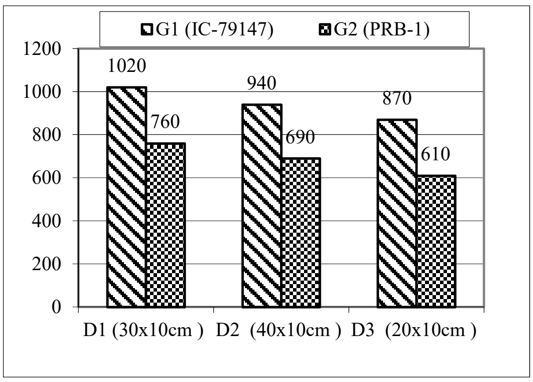

Fig. 1 Buckwheat seed yield (kg ha^{-1}) as influenced by interaction effects of planting geometries and genotypes

B. Interaction Effects of Genotypes and Fertility Levels

Significant differences with respect to seed yield were observed between the genotypes irrespective of fertility levels (Fig. 2). The genotype IC-79147 recorded significantly higher seed yield with all the fertility levels i.e. 60:30 NP kg ha^{-1} (990 kg ha^{-1}) , 40:20 NP kg ha^{-1} (950 kg ha^{-1}) and 20:10 NP kg ha^{-1} (890 kg ha^{-1}) as compared to PRB-1 (700, 670 and 690 kg ha^{-1} respectively). Among the fertility levels irrespective of genotypes, 60:30 NP kg ha^{-1} had given significantly higher seed yield (990 and 700 kg ha^{-1}) as compared to 40:20 NP kg ha^{-1} (950 and 670 kg ha^{-1}) and 20:10 NP kg ha^{-1} (890 and 690 kg ha^{-1}) [7]. Within the interactions, genotype IC-79147 with 60:30 NP kg ha^{-1} fertility level had given significantly higher seed yield (990 kg ha^{-1}) compared to other treatment combinations.

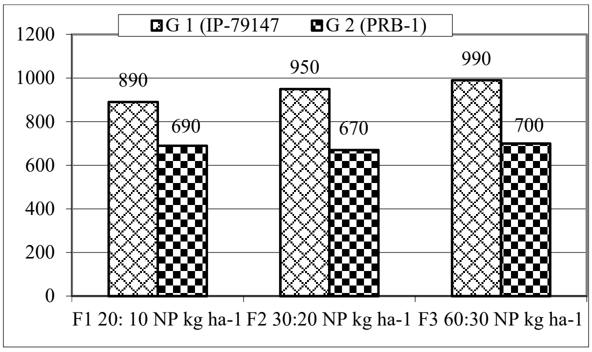

Fig. 2 Buckwheat seed yield (kg ha^{-1}) as influenced by interaction effects of genotypes and fertility levels

C. Interaction Effects of Planting Geometries and Fertility Levels

Seed yield of buckwheat was influenced significantly by planting geometries irrespective of fertility levels (Fig. 3). Planting geometry of 30*10 cm recorded higher seed yield in all the fertility levels tried i.e. 60:30 NP kg ha^{-1} (920 kg ha^{-1}), 40:20 NP kg ha^{-1} (890 kg ha^{-1}) and 20:10 NP kg ha^{-1} (870 kg ha^{-1}) compared to 40*10 cm (840, 810 and 800 kg ha^{-1} respectively) and 20*10 cm (780, 720 and 720 kg ha^{-1} respectively). Among the fertility levels, 60:30 NP kg ha^{-1} recorded significantly higher seed yield with all the planting geometries i.e. 30*10 cm (920 kg ha^{-1}), 40*10 cm (840 kg ha^{-1}) and 20*10 cm (780 kg ha^{-1}) as compared to 40:20 NP kg ha^{-1} (890, 810 and 720 kg ha^{-1} respectively) and 20:10 NP kg ha^{-1} (870, 800 and 720 kg ha^{-1} respectively). Among the treatment combinations, planting geometry of 30*10 with 60:30 NP kg ha^{-1} fertility level was recorded significantly higher seed yield (920 kg ha^{-1}) as compared to other combinations.

V. CONCLUSION

Based on the results explained above, it can be concluded that 1) Buckwheat is well adapted to semi humid and semiarid regions of Karnataka. 2) Buckwheat genotype IC-79147 having planting geometry of 30*10 cm with fertility level of 60:30 NP kg ha^{-1} can be recommended for cultivation in Northern Transition Zone of Karnataka, India.

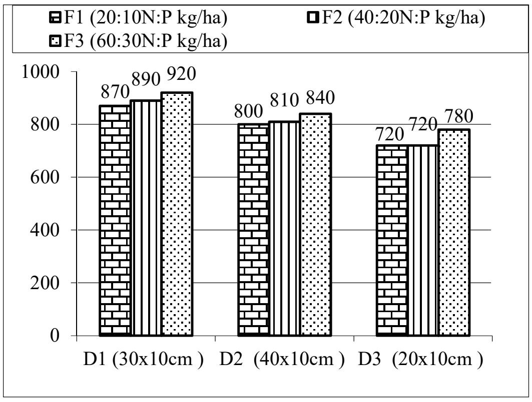

Fig. 3 Buckwheat seed yield (kg ha^{-1}) as influenced by interaction effects of planting geometries and fertility levels

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