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Effect of Land Configuration on Different Crop Based Chickpea Sequences in Dryland Area of Central India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation makes an attempt to study the effect of land configuration on yield, water use efficiency and economics for cropping sequences in dryland area of Central India. Different cropping sequences soybean-chickpea, maize-chickpea and greengram-chickpea were adopted under different sets of land configurations such as Furrow Irrigated Raised Bed (FIRB), Broad Bed Furrow (BBF) and Flat System as Farmer's Practices (FP). Various yield attributes such as plant height, dry matter per plant, branches/plant, pods/cob per plant, seeds/cob per plant, 100 seed weight, seed and stover yield along with Seed Equivalent Yield (SEY), gross and net return, Benefit Cost ratio, Rain Water Use Efficiency (RWUE) were evaluated in this study. In case of SEY, for soybean-chickpea, maximum SEY was observed in FIRB (3197 kg ha^{-1}), followed by BBF (3131 kg ha^{-1}) and FP (2870 kg ha^{-1}). Similarly for maize-chickpea, highest SEY was detected in FIRB (3601 kg ha^{-1}), followed by BBF (3485 kg ha^{-1}) and FP (3241 kg ha^{-1}). A similar trend was obtained for

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greengram-chickpea where FIRB expressed highest value of SEY (2121 kg ha^{-1}) followed by BBF (2065 kg ha^{-1}) and FP (1805 kg ha^{-1}). The analysis of yield attributes along with economics clearly suggested that for all combinations of crop sequences, FIRB yielded better results over BBF and FP. The results obtained through this study clearly advocates the fact that sowing of *rabi* crops on such land configurations (FIRB and BBF) amplifies the crop yield due to the presence of residual moisture which ultimately leads to enhanced farm income.

Keywords: BBF; cropping sequence; dryland; land configuration; yield etc.

1. INTRODUCTION

Kharif crops are a type of seasonal crops mainly grown with the onset of monsoon in India, which usually starts around June and lasts till September. These crops are suited to match India's climatic conditions during this time, which includes high temperature, rainfall and humidity. In the category of *kharif* crops, rice, soybean, maize, greengram (*moong*), pearl millet (*bajra*) and black gram (*urad*) are some of the major crops grown in almost every part of India. Soybean, maize and greengram are some of the prominent crops grown in *kharif* season especially in dryland areas.

Soybean [*Glycine max* (L.) *merril*] is one of the most economical and valuable legume seed which has 25% contribution in global edible oil production. India contributes 10% in total soybean area at global level. Soybean is also known as "Golden Bean", "Miracle Crop" *etc*., because of its several uses. It is a high-value nutritive crop and plays a significant role in overcoming problems of food and nutritional insecurity. In the recent times, it has played a pivotal role in solving the problem of malnutrition as it contains about 20% oil and 40% high quality protein [1].

Maize [*Zea mays* L.] is an important multifunctional cereal crop in the Poaceae family. It is the third most important cereal crop in India after rice and wheat in terms of area and production. The phenomenal increase in cropped area and production of maize has been commensurate with the growth in poultry and allied industry as it is the highest contributor in poultry and animal feed due to its high energy content. Growth of starch industry is also a major contributor in fast progress of maize production as maize starch has maximum use in this industry [2]. It is used in human food, animal and poultry feed, and in industry for several purposes including maize starch, dextrose, maize syrup, and maize flakes [3]. It grows well in a wide range of soil and climatic conditions.

The greengram [*Vigna radiata* L.] also known as *moong* or *moong* bean is an important pulse consumed all over the world, especially in Asian countries. It has a long history of usage as traditional medicine. It is one of the most important edible legume crop, grown on more than 6 Mha worldwide (about 8.5% of the global pulse area) and consumed by most households in Asia. Due to its characteristics of relatively drought-tolerant, low-input crop, and short growth cycle (70 days or so), the greengram is widely cultivated in many Asian countries (concentrated mainly in China, India, Bangladesh, Pakistan, and some Southeast Asian countries) as well as in dry regions of Southern Europe and warmer parts of Canada and the United States [4]. In the predominantly cereal-based diet of China and India, the greengram has been consumed as a common food for centuries. It contains balanced nutrients, including protein, dietary fiber, minerals, vitamins, and significant amounts of bioactive compounds [5]. For individuals who can't afford animal proteins or those who are vegetarian, the greengram bean is of a comparatively low-cost source of protein and has a good source of protein for them. Furthermore, greengram protein is easily digestible, as compared to protein in other legumes [6,7].

Rabi crops also known as winter crops are grown in the month of October or November and are then harvested in spring. Wheat, chickpea, and barley are some of the major *rabi* crops grown in India among which chickpea is prominently grown in dryland areas.

Chickpea [*Cicer arietinum L.*] is the third most important pulse crop worldwide and is cultivated mainly in arid and semi-arid areas in more than fifty countries across the Mediterranean basin, Central Asia, East Africa, Europe, Australia, and North and South America [8,9]. Chickpea is mainly produced in developing countries, where more than 90% of chickpea production is consumed locally [10]. The main chickpea-producing and consuming region is the Indian subcontinent (India, Pakistan, Myanmar, Bangladesh, and Nepal), contributing almost 70% of the world's production [10]. In addition, Turkey, Australia, Ethiopia, Iran, Mexico, Canada, and the USA are other countries with high chickpea production [11].

In dryland region, many times during *kharif* season, crops suffer due to poor drainage during growing stage because of heavy rain and moisture stress in dry spells. The *in-situ* moisture conservation practices make sure the production of crop through safe disposal of runoff or its retention for profile moisture as and when required. Excess rainfall during recent years have severely affected *kharif* crop production, therefore, there is an urgent need to adopt new sowing techniques which can mitigate adverse effect of climate change on soybean production [12]. Most of the farmers use seed drill for sowing of soybean on Flat System, but due to improper drainage in the field, the yield of soybean reduces drastically. The climate smart technology of sowing on changed land configuration (BBF or FIRB) have found to be effective in mitigating the adverse effect of water stress and improvement in soil physical and biological environment. Plants get benefit from the improved drainage and aeration because roots get penetrated readily. The planting of *kharif* crops on altered land configuration [Broad Bed Furrow (BBF) or Furrow Irrigated Raised Bed (FIRB) System] may reduce the deleterious effect of both extreme situations (deficit and excess) of rains as compared to traditional farming practices (Farmer's Practices or FP) [13]. *Kharif* crop can perform better under excess as well as deficit rainfall conditions if sown on ridges instead of Flat System. During *kharif* season, if different types of land configuration are adopted for crop cultivation, the soil moisture remains available for a relatively longer duration. Hence, due to the residual effect of *kharif* crops in terms of soil moisture, the yield of subsequent *rabi* crops grown (especially chickpea) increases. Keeping such points in mind, the present investigation tries to study the effect of land configuration on yield and economics of different cropping sequence in dryland area of Central India.

2. MATERIALS AND METHODS

2.1 Study Area

The field experiment was conducted during *kharif* season of 2022-23 at research field of AICRP for Dryland Agriculture, Indore, Madhya Pradesh. Three main plots as land configuration were adopted for the trial *i.e.,* M1 - Sweep Blade type, M2 - Broad Bed and Furrow (BBF) type and M3 - Furrow Irrigated Raised Bed (FIRB) System. *Kharif* and *rabi* crops were considered as sub-plots for the trial. Split plot statistical design with three replications were applied for the experiment. Soybean (RVS-24), maize (Kanak) and greengram (Deepshikha) in *kharif* season and chickpea (RVG-202) in *rabi* season were sown for the experiment. The plot size was 10.0 m X 5.40 m. The seed rate for soybean, maize and greengram was 80 kg/ha, 20 kg/ha and 20 kg/ha respectively and row to row spacing was maintained at 45 cm. 20:60:40 kg NPK as basal were applied based on recommended dose of fertilizer. The method of hand weeding was adopted to remove weeds from cropped area. At 30 days after sowing, spraying of Chloropyrifos 50% + Cypermethilin 5% @1 lit/ha was done to control diseases for all the crops. The experimental area has clayey soil (clay 59.30%, silt 30.42% and sand 10.28% respectively) with soil depth from medium to deep. The soil has pH of 7.4 and contain 0.44% organic carbon. Availability of Nitrogen, Phosphorus and Potash in the soil of study area is 189 kg/ha, 17.3kg/ha and 265kg/ha, respectively.

2.2 Yield Attributes

The parameters such as plant height, dry matter/plant, branches/plant, pods/cob/plant, seeds/cob/plant, 100 seed weight, seed and stover yield were evaluated for different sequences grown in different land configurations.

2.3 Economic Attributes

The economic attributes such as Soybean Equivalent Yield (SEY), gross return, net return, B:C ratio and Rain Water Use Efficiency (RWUE) were evaluated in the present study.

2.4 Formulas Used

Following formula were used to calculate different parameter as follows:

Net returns (₹/ha) = Gross income (₹/ha) – Total cost of cultivation (₹/ha)

$$\text{B:C ratio} = \frac{\text{Gross returns (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

$$\text{Rain Water Use Efficiency (RWUE)} = \frac{\text{Yield (kg/ha)}}{\text{Rainfall (mm)}}$$

3. RESULTS AND DISCUSSION

3.1 Yield Attributes

The Table 1 shows the effect of land configuration on growth and yield attributes of soybean under different cropping sequences. From the Table 1, it is evident that for soybean, maximum plant height was obtained in FIRB (67.00 cm) followed by BBF (60.56 cm) and FP (48.33 cm). The maximum dry matter/plant was observed in FIRB (21.78 g), followed by BBF (16.67 g) and FP (14.56 g). The highest number of branches per plant was found in FIRB (4.33) followed by BBF (3.89) and FP (3.67). The maximum value of number of seeds/cob per plant was obtained for FIRB (39.56) and lowest value in FP (31.00) and BBF in between them (38.56). The maximum value of number of seeds/cob per plant was detected in FIRB (78.00), followed by BBF (70.89) and FP (53.78). For 100 seed weight, in soybean maximum value was noticed in FIRB (13.00 g) followed by BBF (10.33) and FP (8.00 g). In terms of seed yield, for soybean maximum value was observed in FIRB (1475 kg ha^{-1}) followed by BBF (1382 kg ha^{-1}) and FP (1239 kg ha^{-1}). In case of stover yield, soybean showed maximum value in FIRB (1731 kg ha^{-1}) followed by BBF (1674 kg ha^{-1}) and FP (1475 kg ha^{-1}).

The Table 2 shows the effect of land configuration on growth and yield attributes of maize under different crop sequences. For maize, maximum plant height was observed in FIRB (156.17 cm) followed by BBF (148.17 cm) and FP (136.67 cm). The maximum dry matter/plant was detected in FIRB (125.00 g), followed by BBF (116.33 g) and FP (97.33 g). In terms of pods/cob/plant, maximum value was observed in FIRB (1.30) followed BBF (1.25) and FP (1.22). Similar results were also obtained for seeds/cob/plant which showed FIRB with highest value of 262.20 followed by BBF (249.30) and FP (204.30). For 100 seed weight, maximum value was detected in FIRB (12.53 g), BBF (12.00 g) and FP (10.87 g). The overall better growth, development with the support of conserved soil moisture might have reflected in 100 seed weight [14]. Similar results were also reported by various previous studies [15,16,17].

In terms of seed yield, FIRB showed highest value of 4152 kg ha^{-1} followed by BBF of 3994 kg ha^{-1} and FP = 3644 kg ha^{-1}. The maximum stover yield was obtained in FIRB (5273 kg ha^{-1}), followed by BBF (5190 kg ha^{-1}) and FP (4940 kg ha^{-1}).

The Table 3 shows the effect of land configuration on growth and yield attributes of greengram under different crop sequences. For greengram, the maximum plant height was detected in FIRB (52.11 cm) followed by BBF (49.56 cm) and FP (45.78 cm). A similar trend was also observed for dry matter/plant where FIRB showed highest value of dry matter/plant (15.33 g) followed by BBF (13.44 g) and FP (8.44 g). For branches/plant, highest value of 4.56 was observed in FIRB, 3.67 in BBF and 3.33 in FP. For pods/cob/plant, maximum value was observed in FIRB (12,89) followed by BBF (11.11) and FP (10.22). For greengram, highest seeds/cob/plant was detected in FIRB (46.00) followed by BBF (39.78) and FP (27.00). The maximum value of 100 seed weight was obtained in FIRB (7.67 g) and least value was obtained in FP (6.33 g) whereas a moderate value (7.00 g) was obtained in BBF between FIRB and FP. The seed yield (FIRB = 259 kg ha^{-1}, BBF = 246 kg ha^{-1} and FP = 225 kg ha^{-1}) and stover yield (FIRB = 685 kg ha^{-1}, FP = 685 kg ha^{-1} BBF = 664 kg ha^{-1}) also gave results in similar pattern.

3.2 Yield and Economic Attributes

The Table 4 shows the effect of land configuration on yield and economics of soybean. It is evident from the Table 4, that maximum crop yield was obtained under FIRB (1475 kg ha^{-1}) followed by BBF (1382 kg ha^{-1}) and FP (1239 kg ha^{-1}). Under FIRB, the yield of chickpea was found as 1637 kg ha^{-1} followed by BBF with yield of 1578 kg ha^{-1} and FP as 1450 kg ha^{-1}. In case of SEY, for soybean-chickpea, maximum SEY was observed in FIRB (3197 kg ha^{-1}), followed by BBF (3131 kg ha^{-1}) and FP (2870 kg ha^{-1}).

For soybean-chickpea cropping sequences, maximum gross return was obtained in FIRB (1,43,860 ₹ ha^{-1}) followed by BBF (1,40,910 ₹ ha^{-1}) and FP (1,29,155 ₹ ha^{-1}). In terms of net return, maximum net return was obtained in FIRB (94,860 ₹ ha^{-1}), followed by BBF (91,910 ₹ ha^{-1}) and FP (82,155 ₹ ha^{-1}). The maximum B:C ratio was obtained in FIRB (2.94), followed by BBF (2.88) and FP (2.75). The highest RWUE was obtained in FIRB (1.30 kg/ha - mm) followed by BBF (1.24 kg/ha - mm) and FP (1.13 kg/ha - mm).

Table 1. Effect of land configuration on growth and yield attributes of soybean under different crop sequences

Treatments	Plant Height	Dry Matter /Plant	Branches /Plant	Pods/Cob /Plant	Seeds/ Cob/Plant	100 Seed Weight	Seed Yield	Stover Yield
	(cm)	(g)	(No.)	(No.)	(No.)	(g)	(kg ha^{-1})	(kg ha^{-1})
FP S1- Soybean-Chickpea	48.33	14.56	3.67	31.00	53.78	8.00	1239	1475
BBF S1-Soybean-Chickpea	60.56	16.67	3.89	38.56	70.89	10.33	1382	1674
FIRB S1-Soybean-Chickpea	67.00	21.78	4.33	39.56	78.00	13.00	1475	1731

Table 2. Effect of land configuration on growth and yield attributes of maize under different crop sequences

Treatments	Plant Height	Dry Matter /Plant	Branches /Plant	Pods/Cob /Plant	Seeds/ Cob/Plant	100 Seed Weight	Seed Yield	Stover Yield
	(cm)	(g)	(No.)	(No.)	(No.)	(g)	(kg ha^{-1})	(kg ha^{-1})
FP S2-Maize-Chickpea	136.67	97.33	-	1.22	204.30	10.87	3644	4940
BBF S2-Maize-Chickpea	148.17	116.33	-	1.25	249.30	12.00	3994	5190
FIRB S2-Maize-Chickpea	156.17	125.00	-	1.30	262.20	12.53	4152	5273

Table 3. Effect of land configuration on growth and yield attributes of greengram under different crop sequences

Treatments	Plant Height	Dry Matter /Plant	Branches /Plant	Pods/Cob /Plant	Seeds/ Cob/Plant	100 Seed Weight	Seed Yield	Stover Yield
	(cm)	(g)	(No.)	(No.)	(No.)	(g)	(kg ha^{-1})	(kg ha^{-1})
FP S3-Greengram-Chickpea	45.78	8.44	3.33	10.22	27.00	6.33	225	685
BBF S3-Greengram-Chickpea	49.56	13.44	3.67	11.11	39.78	7.00	246	664
FIRB S3-Greengram-Chickpea	52.11	15.33	4.56	12.89	46.00	7.67	259	685

Table 4. Effect of land configuration on yield and economics of soybean

Treatments	Yield		Soybean equivalent yield	Gross return	Net return	B:C ratio	RWUE (*Kharif* crops)
	Kharif crops	*Rabi* crops					
	(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	(₹ ha^{-1})	(₹ ha^{-1})	(-)	(kg/ha - mm)
FP S1- Soybean-Chickpea	1239	1450	2870	1,29,155	82,155	2.75	1.13
BBF S1-Soybean-chickpea	1382	1578	3131	1,40,910	91,910	2.88	1.24
FIRB S1-Soybean -Chickpea	1475	1637	3197	1,43,860	94,860	2.94	1.30

Table 5. Effect of land configuration on yield and economics of maize

Treatments	Yield		Soybean equivalent yield	Gross return	Net return	B:C ratio	RWUE (*Kharif* crops)
	Kharif crops	*Rabi* crops					
	(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	(₹ ha^{-1})	(₹ ha^{-1})	(-)	(kg/ha - mm)
FP S2-Maize-Chickpea	3644	1459	3241	1,45,830	98,830	3.10	3.27
BBF S2-Maize-Chickpea	3994	1519	3485	1,56,830	1,07,830	3.20	3.63
FIRB S2-Maize-Chickpea	4152	1580	3601	1,62,040	1,13,040	3.31	3.72

Table 6. Effect of land configuration on yield and economics of greengram

Treatments	Yield		Soybean equivalent yield	Gross return	Net return	B:C ratio	RWUE (*Kharif* crops)
	Kharif crops	*Rabi* crops					
	(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	(₹ ha^{-1})	(₹ ha^{-1})	(-)	(kg/ha - mm)
FP S3-Greengram-Chickpea	225	1452	1881	84,660	37,660	1.80	0.18
BBF S3-Greengram-Chickpea	246	1578	2065	92,940	43,940	1.90	0.21
FIRB S3-Greengram-Chickpea	259	1644	2121	95,460	46,460	1.95	0.25

The Table 5 shows the effect of land configuration on yield and economics of maize. It is evident from the Table 5 that in terms of maize productivity, FIRB have given best results over BBF and FP (FIRB = 4152 kg ha^{-1}, BBF = 3994 kg ha^{-1} and FP = 3664 kg ha^{-1}). Under FIRB, the yield of chickpea was found as 1580 kg ha^{-1} followed by BBF with yield of 1519 kg ha^{-1} and FP as 1459 kg ha^{-1}. For maize-chickpea, highest SEY was detected in FIRB (3601 kg ha^{-1}), followed by BBF (3485 kg ha^{-1}) and FP (3241 kg ha^{-1}).

For maize-chickpea cropping sequences, maximum gross return was obtained in FIRB (1,62,040 ₹ ha^{-1}), followed by BBF (1,56,830 ₹ ha^{-1}) and FP (1,45,830 ₹ ha^{-1}). In terms of net return, maximum net return was obtained in FIRB (1,13,040 ₹ ha^{-1}), followed by BBF (1,07,830 ₹ ha^{-1}) and FP (98,830 ₹ ha^{-1}). The maximum B:C ratio was obtained in FIRB (3.31), followed by BBF (3.20) and FP (3.10). The maximum RWUE was shown by FIRB (3.72 kg/ha - mm) followed by BBF (3.63 kg/ha - mm) and FP (3.27 kg/ha - mm).

The Table 6 shows the effect of land configuration on yield and economics of greengram. It is evident from the Table 6 that in terms of greengram productivity, FIRB have shown best result with yield of 259 kg ha^{-1} followed by BBF with yield of 246 kg ha^{-1} and FP with 225 kg ha^{-1}. Under FIRB, the yield of chickpea was found as 1644 kg ha^{-1} followed by BBF with yield of 1578 kg ha^{-1} and FP as 1452 kg ha^{-1}. A similar trend was also obtained for greengram-chickpea where FIRB expressed highest value of SEY (2121 kg ha^{-1}) followed by BBF (2065 kg ha^{-1}) and FP (1881 kg ha^{-1}).

For greengram-chickpea cropping sequences, maximum gross return was obtained in FIRB (95,460 ₹ ha^{-1}), followed by BBF (92,940 ₹ ha^{-1}) and FP (84,660 ₹ ha^{-1}). In terms of net return, maximum net return was obtained in FIRB (46,460 ₹ ha^{-1}), followed by BBF (43,940 ₹ ha^{-1}) and FP (37,660 ₹ ha^{-1}). The maximum B:C ratio was obtained in FIRB (1.95), followed by BBF (1.90) and FP (1.80). The maximum RWUE was shown by FIRB (0.25 kg/ha - mm) followed by BBF (0.21 kg/ha - mm) and FP (0.18 kg/ha - mm).

Table 7. Soybean Equivalent Yield (SEY), net returns and B:C ratio of different crop sequences

Treatment	**Soybean Equivalent Yield (kg ha^{-1})**			
	FP	**BBF**	**FIRB**	**Mean**
Soybean-Chickpea	2870	3131	3197	3066
Maize-Chickpea	3241	3485	3601	3442
Greengram-chickpea	1881	2065	2121	2023
Mean	2664	2894	2973	
	Land configuration	**Cropping system**		
Sem ±	55	52		
CD (p=0.05)	214	161		
Net returns (₹ ha^{-1})				
Soybean-Chickpea	82,155	91,910	94,860	89,642
Maize-Chickpea	98,830	1,07,830	1,13,040	1,06,567
Greengram-chickpea	37,660	43,940	46,460	42,687
Mean	72,882	81,227	84,787	
	Land configuration	**Cropping system**		
SEm±	1646	1587		
CD (p=0.05)	6463	4891		
B:C ratio				
Soybean-Chickpea	2.75	2.88	2.94	2.85
Maize-Chickpea	3.10	3.20	3.31	3.20
Greengram-chickpea	1.80	1.90	1.95	1.88
Mean	2.55	2.66	2.73	
	Land configuration	**Cropping system**		
SEm±	0.05	0.05		
CD (p=0.05)	0.20	0.15		

The Table 7 shows the details of SEY, net returns and B:C ratio of different crop sequences. It is evident from the table, that SEY was maximum in FIRB (soybean-chickpea = 3197 kg ha^{-1}, maize-chickpea = 3601 kg ha^{-1} and greengram-chickpea = 2121 kg ha^{-1}) as compared to BBF (soybean-chickpea = 3131 kg ha^{-1}, maize-chickpea = 3485 kg ha^{-1} and greengram-chickpea = 2065 kg ha^{-1}) and FP (soybean-chickpea = 2870 kg ha^{-1}, maize-chickpea = 3241 kg ha^{-1} and greengram-chickpea = 1881 kg ha^{-1}).

4. CONCLUSION

From the present study, it can be concluded that higher productivity with maximum net return and B:C ratio can be obtained for different cropping sequences (soybean-chickpea, maize-chickpea and greengram-chickpea) by adopting climate-smart sowing techniques such as Furrow Irrigated Raised Bed (FIRB) and Broad Bed Furrow (BBF) as compared to Flat System as Farmer’s Practice. The study also demonstrated that crop sequences under FIRB has show best result as compared to the corresponding crop sequences under BBF and FP. Such results clearly indicate that FIRB and BBF are the most effective land configuration methods of crop cultivation for different crop sequences as it helps in improving crop performance, optimizing resource utilization when compared with traditional farming practices. However, the results have revealed that FIRBS shows more superior results over BBF in terms of yield attributes and economics.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rahangdale N, Kumawat N, Jadav ML, Bhagat DV, Singh M, Yadav RK. Symbiotic efficiency, productivity and profitability of soybean as influenced by liquid bio-inoculants and straw mulch. International Journal of Bio-resource and Stress Management. 2022;13(1):9-16.
2. Gheith EMS, Lamlom SF, Abdelsalam NR, Kandil EE. Maize (*Zea mays* L.) productivity and nitrogen use efficiency in response to nitrogen application levels and time. Frontiers in Plant Science. 2022;13: 941343.
3. Gul H, Rahman S, Shahzad A, Gul S, Qian M, Xiao Q, Liu Z. Maize (*Zea mays* L.) productivity in response to nitrogen management in Pakistan. American Journal of Plant Sciences. 2021;12(8) :1173-1179.
4. Dahiya PK, Linnemann AR, Van Boekel MAJS, Khetarpaul N, Grewal RB, Nout MJR. Mung bean: Technological and nutritional potential. Crit. Rev. Food Sci. Nutr. 2015;55:670–688.
5. Gan RY, Lui WY, Wu K, Chan CL, Dai SH, Sui ZQ, Corke H. Bioactive compounds and bioactivities of germinated edible seeds and sprouts: An updated review. Trends in Food Science & Technology. 2017;59:1-14.
6. Mubarak AE. Nutritional composition and antinutritional factors of mung bean seeds (*Phaseolus aureus*) as affected by some home traditional processes. Food Chemistry. 2005;89(4):489-495.
7. Yi-Shen Z, Shuai S, FitzGerald R. Mung bean proteins and peptides: Nutritional, functional and bioactive properties. Food & Nutrition Research. 2018;62.
8. Bar-El Dadon S, Abbo S, Reifen R. Leveraging traditional crops for better nutrition and health-The case of chickpea. Trends in Food Science & Technology. 2017;64:39-47.
9. Maphosa L, Richards MF, Norton SL, Nguyen GN. Breeding for abiotic stress adaptation in chickpea (*Cicer arietinum* L.): A comprehensive review. Crop Breeding, Genetics and Genomics. 2020;4(3).
10. Jain M, Misra G, Patel RK, Priya P, Jhanwar S, Khan AW, Chattopadhyay D. A draft genome sequence of the pulse crop chickpea (*Cicer arietinum* L.). The Plant Journal. 2013;74(5):715-729.
11. Jukanti AK, Gaur PM, Gowda CLL, Chibbar RN. Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.): A review. British Journal of Nutrition. 2012; 108(S1):S11-S26.
12. Negi A, Chandra S, Chilwal A, Bora R. Growth analysis of soybean varieties

under different land configurations in mollisols of Himalayan Tarai. Journal of Pharmacognosy and Phytochemistry. 2018;7(6):793-796.

13. Jadav ML, Raidas DK, Kumawat N, Girothia OP, Bhagat DV, Choudhary SK. Pigeonpea (*Cajanus cajan* L.) growth, yield and monetary influence by drip irrigation and mulch in vertisols of Madhya Pradesh. Legume Research - An International Journal. 2022;45(7):853-859.
14. Thoke SB, Asewar BV, Shinde PP, Pendke MS. Effect of mechanization and land configuration on yield of soybean (*Glycine max* (L.) Merrill). The Pharma Innovation J. 2022;11(12):5348 5352.
15. Khambalkar VP, Waghmare NN, Gajakos AV, Karale DS, Kankal US. Performance of broad bed-furrow planter in winter season of dryland crops. Int. Agric. Eng. J. 2014;23:14-22.
16. Meena VK, Karel AS. Effect of land lay out and depth of irrigation on safflower (*Carthamus tinctorius* L.) In Marathwada region Maharashtra. Agriculture for Sustainable Development. 2013;1:1-6.
17. Negi A, Chandra S, Chilwal A, Bora R. Growth analysis of soybean varieties under different land configurations in mollisols of Himalayan Tarai. Journal of Pharmacognosy and Phytochemistry. 2018;7(6):793-796.

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