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Resource-use efficiency of common bean (*Phaseolus vulgaris* L.) as influenced by tillage and residue management under temperate Kashmir valley, India

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ABSTRACT

A field experiment on resource-use efficiency of common bean (P*haseolus vulgaris* L.) as influenced by tillage and residue management under temperate Kashmir valley was conducted at Faculty of Agriculture, Sher-e-Kashmir university of Agricultural Sciences & Technology of Kashmir, Wadura during kharif 2018. The site of the experiment was ideal for common beans due to its silty clay loam texture that provided a medium level of soil organic carbon and readily available primary nutrients. The experiment was conducted in randomized block design (factorial) comprising of four type of tillage systems namely conventional (CT), rotary (RT), minimum (MT), and zero tillage (ZT) as the first factor. Two residue management practices, i.e., no residue (NR) and application of brown sarson residue (SR) were supplemented to all the tillage treatment as the second factor. The results revealed that seed yield in zero tillage was comparable to conventional tillage. Seed yield and biological yield was also increased in residue application. Resource-use efficiency like nutrient-use efficiency and irrigation water-use efficiency was significantly higher with rotary tillage followed by conventional tillage. Contrary to nutrient use efficiency and irrigation water use efficiency, energy-use efficiency was significantly higher with zero tillage and rotary tillage irrespective of residue management. Residue application also increased the resource use efficiency of common bean. The effect of zero tillage and residue application on resource-use efficiency would advance after some extended period of the treatment application.

***Key words**: Bean, Resource, Residue, Tillage*

Introduction

Common bean is an essential component of a balanced diet because it is a significant source of protein, carbohydrate, fat, and minerals (Nanda and Agrawal, 2009). It is recognised as a crucial functional and preventive meal with a high concentration of chemically varied components that protect against oxidative stress, cardiovascular illnesses, diabetes, metabolic syndrome, and cancer (Camara *et al*., 2013). The crop is grown under rainfed conditions throughout the summer/kharif season in the temperate Kashmir valley. 50% of the grain legumes consumed worldwide are common beans (Mc Connell, 2010). Globally, it is grown on an area of 29.39 million hectares (m ha) in sub-tropical and temperate climates, with a production of 26.83 million tonnes (mt) and an average productivity of 0.91 t/ha (FAO, 2016). According to reports, tillage procedures significantly and favourably affect crop output, particularly by improving soil qualities and promoting good seedling establishment through improved root growth and crop yield (Okeleye and Oyekanmi, 2003). Brown sarson crop residue would be left on the soil surface in an effort to improve soil qualities. It can remain on the soil surface under zero-till conditions or be absorbed into the soil by ordinary ploughing. Having prior crop residue from maize and wheat cultivated in the kharif and *Rabi* season, respectively, allows greengram to be effectively grown in the summer under zero till conditions (Saad *et al.,* 2015). Common bean yield decreased when there was no residual under zero till conditions (Bhat *et al.,* 2019). In rainfed areas, conserving soil moisture through tillage practises is a crucial management goal for crop production. Conventional tillage required 20% higher energy inputs than the zero tillage in absence of residue, while residue addition increased the energy output in tillage practices. The studies of tillage and residue application in common bean are meagre, therefore the present experiment was conducted to study on performance of common bean under different tillage and residue management in temperate Kashmir valley.

Materials and Methods

The experiment was conducted at Faculty of Agriculture during kharif, 2018 at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura, Sopore. The experimental soil was silty clay loam with good drainage and normal in reaction and salinity. The mean temperature ranged between 14.4 – 28.6 ^{0}C during the crop period. The total precipitation received was about 340mm with well distributed during the crop period. The ideal temperature ranged and water requirement for proper growth and productivity of common bean is 10-27 ^{0}C and 300 mm, respectively, indicating the weather conditions was well suited for this crop. The soil organic carbon and available NPK were in medium range. The experimental design was randomised block design having two factors. The first factor was tillage systems viz; conventional tillage (CT); rotary tillage (RT); minimum tillage (MT); and zero tillage (ZT). The other factor was residue management viz; no residue (NR) and brown sarson residue (SR). After harvesting of previous crop brown sarson, one- third of anchored residues of it was left in the plots of residue treatment. It was incorporated in the soil through tillage operation in all the tillage treatment except zero tillage, where it was retained on the soil surface. CT was achieved by many successive tillage operations with MBplough followed by harrowing. RT was accomplished by Rotavator Machine while MT was performed with only primary operations using disc harrow. Non selective and systemic herbicide glyphosate (1.0 kg ha^{-1}) was applied before sowing in plots of ZT and MT to kill all the vegetation. Before planting, full dose of nitrogen (30 kg N ha^{-1}), phosphorus (60 kg P_2O_5 ha^{-1}) and potassium (30kg K_2O ha^{-1}) were applied in narrow furrows at row distance of 30cm opened manually in all the tillage treatment except in ZT. The crop was sown on 23rd standard meteorological week (SMW) and harvest on 40th standard meteorological week (SMW) having crop duration 95 days. All the parameters of resource-use efficiency were statistically compared among the treatment.

Results and Discussion

Seed yield and biological yield of common bean

The biological yield and seed yield obtained in ZT and MT were at par but significantly lower than that of CT and RT. These yield parameters were significantly higher than that of CT (Fig. 1). However, seed yield obtained in CT were at par to RT. The seed yield in ZT and MT were also at par to CT (fig 1). Irrespective of tillage, seed yield and biological yield of rajmash were significantly higher with application of sarson residues (Fig. 2). These yield parameters were not influenced due to interaction effect of tillage and residue management. Tillage provided more favourable conditions for crop, better soil moisture, better root growth, nodulation, efficient nutrient supply, resulting higher yields and uptake under rotary and conventional tillage. Many workers have reported relevant findings on tillage and residue management affecting yield of various crops. According to Saad *et al*. (2015) greengram can be successfully grown in summer under zero tilled condition having residue previous crop(wheat and maize). Bhat *et al*. (2019) reported that productivity of maize and bean additive intercropping system

(1:1) was significantly higher with conventional tillage systems followed by zero tillage systems under Kashmir valley.

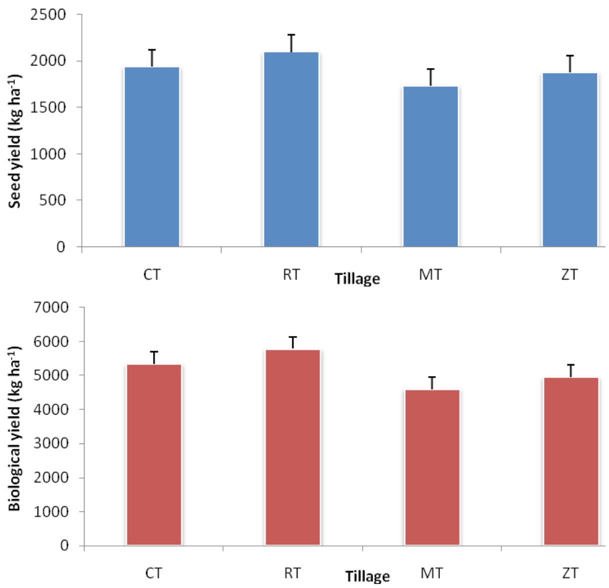

Fig. 1. Seed yield and biological yield (kg ha^{-1}) of common bean as influenced by tillage systems

Resource-use efficiency

Nutrient-use efficiency (NUE) and irrigation water-use efficiency (IWUE) were significantly higher with RT followed by CT irrespective of residue management (Table 1) However, NUE and IWUE in ZT was at par to CT. Residue of sarson application significantly increased these resource-use efficiency irrespective of tillage. No significant variations of NUE and IWUE were observed among interaction treatment of tillage and residue management. Since the equal amounts of synthetic fertilizer of N, P and K and irrigation water were applied in all the treatment plots. However, contrast to NUE and IWUE, energy-use efficiency (EUE) was significantly higher with ZT and RT irrespective of residue management. The minimum EUE was estimated with CT and MT. Application of sarson residue did not influence EUE irrespective of tillage. No significant variations of EUE were also observed among interaction treatments of tillage and residue management. Energy-use efficiency is estimated based on total input energy incurred in all the resources ap-

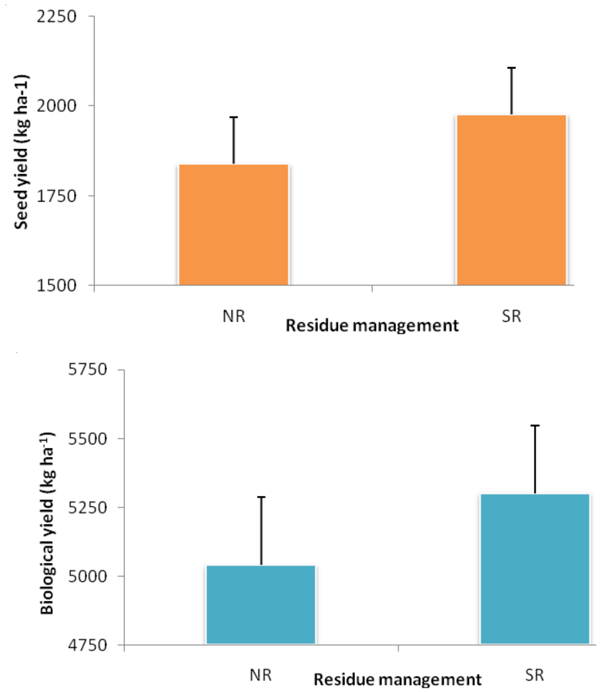

Fig. 2. Seed yield and biological yield of common bean as influenced by residue management.

Table 1. Resource-use efficiency of common bean as influenced by tillage and residue management

Treatments	Nutrient-use efficiency (kg/kg NPK)	Irrigation water-use efficiency (kg/m^{3}IW)	Energy-use efficiency
Tillage Systems			
CT	23.85	3.87	7.35
RT	25.79	4.19	10.92
MT	21.32	3.46	8.00
ZT	23.07	3.75	10.74
SEm ±	0.74	0.12	0.22
CD (P≤0.05)	2.24	0.36	0.67
Residue management			
NR	22.65	3.68	9.02
SR	24.36	3.96	9.48
SEm ±	0.52	0.08	0.16
CD (P≤0.05)	1.59	0.26	NS

plied and operations followed as per the treatment of tillage and residue management. The minimum energy was invested with ZT and the maximum was with CT followed by MT and RT. The input energy saved in ZT was mainly contributes from field preparation and weed management through interculturing operations. The energy saved in RT was due to single machinery i.e., rotavator was used for land preparation. The labour engagement from land preparation to harvesting was more with conventional tillage followed by rotary tillage, minimum tillage and zero tillage. The output energy was the highest with RT followed by CT and ZT. But EUE, which is a ratio of total output energy to total input energy was significantly higher with RT and ZT. Sangar *et al. (*2005) reported that ZT decreased diesel consumption by 50-60 litres/ha. Marwat *et al.* (2007) reported that CT required 20% higher energy inputs than ZT in absence of residue, while residue addition increased the output energy in both tillage practices. Similar kind of results were also reported by Meena, *et al*. (2015); Alluvione *et al*. (2011) and Saad *et al*. (2016)

Conclusion

From the above findings it can be concluded that seed yield and biological yield of common bean were more in favour with rotary and conventional tillage. However, seed yield in zero tillage was comparable to that of conventional tillage.Irrespective of tillage systems, application of sarson residue significantly increased NUE and IWUE. However, energy-use efficiency (EUE) was significantly higher with ZT and RT. The lower EUE was estimated with CT and MT. Application of sarson residue did not influence EUE. The least labour engagement was with zero tillage followed by minimum tillage, rotary tillage than conventional tillage. The effect of zero tillage and residue application on resource-use efficiency would advance after some extended period of the treatment application.

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Conflict of interest

There is no conflict of interest.

References

Alluvione, F., Moretti, B., Sacco, D. and Grignani, C. 2011. Energy use efficiency (EUE) of cropping systems for a sustainable agriculture. *Energy.* 36(7): 446-448.

Bhat, Suhail, Faayz, Saad, A.A., Masood, Amjad, Nazir, Aijaz. and Rasool, Kowsar, 2019. Yield and yield attributes of maize and bean as influenced by intercropping under various tillage and fertilizer management practices in Kashmir Valley. *Research Journal of Agricultural Sciences.* 10(3): 552-557.

Camara, C.R.S., Urrea, C.A. and Schlege, V. 2013. Pinto beans (*Phaseolus vulgaris* L.) as a Functional Food: Implications on Human Health. *Agriculture.* 3: 90-111.

FAO.2016; http://faostat3.Fao.org/browse/O/OC/E

Marwat, Khan Bahadur., Arif, Mohammad., Khan, Mohammad Azim. 2007. Effect of tillage and zinc application methods on weeds and yield of maize. *Pakistan Journal Botany.* 39(5) : 1583-1591.

Mc Connell, M., Mamidi, S., Lee, R., Chikara, S., Rossi, M., Papa, R. and Mc Clean, P. 2010. Syntonic relationship among legumes revealed using a gene-based genetic linkage map of common bean (*Phaseolus vulgaris* L.). *Theoretical and Applied Genetics.* 121: 1103-1116.

Meena, J.R., Behera, U.K., Chakraborty, D. and Sharma, A.R. 2015. Tillage and residue management effect on soil properties, crop performance and energy relations in green gram under maize-based cropping systems. *International Soil and Water Conservation Research.* **3**(4): 261-272.

Nanda, J. S. and Agrawal, P.K. 2009. Pulses and grain legumes. In: *Botany of Field Crops: Cereals, Pulses and Oilseed Crops*. Kalyain publisher, Ludhina. India. P. 184.

Okeleye, K.A. and Oyekanmi, A.A. 2003. Influence of tillage systems and nitrogen fertilizer levels on growth and yield of maize. *Moor Journal of Agricultural Research.* 4(1): 26-36.

Saad, A.A., Das, T.K., Rana, D. S., and Sharma, A.R. 2015. Productivity resource-use efficiency and economics of maize (*Zea mays*)-wheat (*Triticum aestivum*) greengram (*Vigna radiata*) cropping system under conservation agriculture in irrigated north-western Indo-Gangetic plains. *Indian Journal of Agronomy* 60 (4): 502-510.

Saad, A.A., Das, T. K., Rana, D.S., Sharma, A.R., Bhattacharyya, R. and Lal Krishan. 2016. Energy auditing of a maize -wheat-greengram cropping system under conventional and conservation agriculture in irrigated north-western Indo-Gangetic Plains. *Energy.* 116: 293-305.

Sangar, S., Abrol, I.P. and Gupta, K. K. 2005. Conservation Agriculture: Conserving Resource Enhancing Productivity. Centre for Advancement of Sustainable Agriculture, NASC Complex, New Delhi pp.19.