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Effect of tillage practices and fertility levels on growth, yield and quality of clusterbean (*Cyamopsis tetragonoloba*.)

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ABSTRACT

A field experiment was conducted during kharif seasons of 2016 and 2017 at the Research Farm, College of Agriculture, Gwalior (M.P.) to study the effect of tillage practices and fertility levels on growth, yield and quality of clusterbean [Cyamopsis tetragonoloba (L.) Taub]. The treatments comprised of four levels each of tillage system and fertility levels were evaluated in split plot design with three replications. The results revealed that minimum tillage having one cultivation plus 3 t ha^{-1} wheat residue resulted in significantly highest growth and yield parameters, grain yield (17.62 q ha^{-1}), net income (Rs.38054 ha^{-1}), grain protein (32%), protein yield 516 kg ha^{-1}, gum content in grain (29.97%) and gum yield (540 kg ha^{-1}). Application of 100% RDF ($N_{20}P_{40}K_{20}$) recorded significantly highest growth and yield parameters, yield, quality and economical gain from clusterbean var. HG-563. The combined input of minimum tillage + 3 t ha^{-1} wheat residue + 100% RDF further enhanced the grain yield, quality and economic gain synergistically.

Key words: Fertility, tillage practices, quality, yield, clusterbean

INTRODUCTION

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub], commonly known as guar, is an annual *kharif* legume grown for green fodder, vegetable, green manuring gumand seed purposes. Being drought - tolerant and hardy, the crop is cultivatedunder rainfed condition. Its deep penetrating root system enables the plant to utilize soil moisture more efficiently and offers better scope for rainfed cropping. Tillage is performed by ploughing, harrowing and levelling processes to make the land soft and friable for sowing. The deep and repeated tillage operations apart from requiring more time, demanding more energy and labour are becoming scarce and costlier. The tillage system can impact soil moisture status because it influences infiltration, run off, evaporation and soil water storage. Due to several reasons, no-till or reduced tillage has been found more beneficial than the conventional tillage (Cara *et al.*, 2010 and Javeed *et al.*, 2013). Soil texture further influences the choice of a suitable tillage system for optimizing the yields during moisture-stress periods. Organic manures and crop residues are the important constituents of integrated nutrient management system which improves physico-chemical and biological properties of the soil and consequently the productivity on sustainable basis (Sunil Kumar *et al.*, 2018). For the proper recycling of organic wastes, conventional minimum tillage practices have their own unique role as per requirement. There was a need to study the interactive effect of certain tillage practices with applied crop residues and NPK levels on the productivity of clusterbean under the existing agro-climatic conditions of Gwalior region; hence the present research was taken up.

MATERIALS AND METHODS

The field experiment was conducted was carried out at the Research farm, College of Agriculture, Gwalior (M.P.) during *kharif* seasons of 2016 and 2017. The soil of the experimental field was silty clay-loam having pH 8.0, electrical conductivity 0.12 dSm^{-1}, organic carbon 4.61 g kg^{-1}, available nitrogen, phosphorus and potassium 216.0, 16.52 and 284 kg ha^{-1}, respectively. The total rainfall received during the crop season was 461.6 and 458.7 mm in 2016 and 2017, respectively. The treatments comprised four tillage systems (conventional 3 cultivations, minimum 1 cultivation, conventional + wheat residual retention @ 3 t ha^{-1}, minimum + wheat residual retention @ 3 t ha^{-1}) as the main-plot treatments and four fertility levels (control, 50, 75 and 100% RDF i.e. $N_{20}P_{40}K_{20}$) as the sub-plot treatments. The experiment was laid out in split-plot design with three replications.

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Clusterbean var. HG-563 was sown on 18 and 10 July 2016 and 2017, respectively @ 20 kg seed ha^{-1} in rows 45 cm apart. The crop was grown as per recommended package of practices under rainfed conditions. The crop was harvested on 2 and 5 November 2016 and 2017 respectively. The growth and yield attributes were recorded at maturity. Seed and stover yields were recorded at harvest. Seed protein and gum content were estimated by the standard procedures (A.O.A.C., 1997). The data were statistically analysed by adopting standard procedures.

RESULTS AND DISCUSSION

Growth parameters

The data (Table 1) indicate that the minimum tillage + 3t ha^{-1} wheat residue recorded significantly higher plant height (104.6 cm) and biomass/plant (46.2 g), whereas under conventional tillage, the height was 99.8 cm and biomass 38.33 g $plant^{-1}$. The minimum tillage along with wheat residue addition created most favourable aggregate soil structure with decreased decomposition of crop residue and slow mineralization of organic .matter, protected availability of plant nutrients and conserved soil moisture. On the other hand, under conventional tillage, three ploughing might have disrupted the aggregate soil structure and increased the decomposition of incorporated crop residue and mineralization of soil organic matter that was protected within the structure of the soil. The advantage of zero or minimum tillage on growth parameters has been reported by Ayub *et al.* (2012) and Sharma and Jain (2012).The recommended dose of fertilizers ($N_{20}P_{40}K_{20}$) brought about significantly higher plant height, branches and biomass $plant^{-1}$. This was on account of the combined unique functions of N, P and K to boost up plant growth with increased photosynthesis. The remarkable development of root-shoot growth parameters due to 100% NPK supplying additional nutrients may be as a result of acceleration of cell elongation and cell division. Similar findings were reported by Patel *et al.* (2010), Saket*et al.* (2014), Gadi*et al.* (2018) and Singh (2018).

Table 1: Growth and yield-attributing parameters of clusterbean as influenced by tillage practices and fertility levels (Mean of 2 years)

Treatments	Plant height (cm)	Branches $plant^{-1}$	Biomass $plant^{-1}$ (g)	Pods $plant^{-1}$	Pod length (cm)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
Tillage practices								
Conventional (3 cultivation)	99.8	7.16	38.33	76.1	4.64	14.06	37.23	37.9
Minimum (1 cultivation)	102.7	7.56	44.31	84.0	5.12	15.97	39.56	39.6
Conv.+ 3 t ha^{-1} wheat residue	102.5	7.43	42.87	80.8	5.07	15.88	39.63	40.6
Mini.+ 3 t ha^{-1} wheat residue	102.7	7.52	46.22	82.2	5.36	17.62	41.46	41.8
C.D. (P=0.05)	2.73	NS	4.01	3.17	0.25	1.10	0.77	3.17
Fertility levels								
Control	100.2	6.17	40.10	75.5	4.67	13.95	36.91	38.4
50% RDF ($N_{10}P_{20}K_{10}$)	102.2	7.54	43.31	81.2	5.06	15.58	39.65	39.7
75% RDF ($N_{15}P_{30}K_{15}$)	103.3	7.59	43.26	82.9	5.08	16.42	39.77	40.9
100% RDF ($N_{20}P_{40}K_{20}$)	104.0	8.37	45.06	83.3	5.36	17.59	41.40	41.9
CD (P=0.05)	2.18	0.70	2.52	3.62	0.51	0.72	0.64	1.83

Con. = Conventional; Mini. = Minimum; NS = Non significant; Sig. = Significant

Yield attributes

The minimum tillage (MT) + wheat residue (WR) resulted in significantly higher pod formation (82.2 $plant^{-1}$) and pod length (5.36 cm) over conventional tillage. Whereas lower values of these parameters were recorded under conventional tillage. The higher yield attributes due to MT+WR may be owing to maximum increase in physico-chemical and biological properties of soil, enhanced growth parameters and plant biomass with efficient and greater, partitioning of metabolites towards reproductive structures. These findings are in consonance with those of Javeed *et al.* (2013), Omandi *et al.* (2014) and Sunil Kumar (2018). Application of 100% RDF produced highest (83.3) pods /plant and (5.36 cm) pod lengthfollowed by

75% NPK and minimum in control. This may be owing to increased growth and biomass /plant as a result of increased supply of NPK, thereby playing multifarious role in the greater accumulation of carbohydrates, proteins and their translocation from source to the sink (reproductive organs). These results agree with those of Sharma *et al.* (2011), Gadi *et al.* (2018, Pandey *et al.* (2018) and Singh (2018).

Productivity and economics

The tillage practice (minimum tillage + wheat residue) recorded significantly higher seed (17.62 q ha^{-1}) and stover yield (41.46 q ha^{-1}) and harvest index (41.8%), hence the highest net income (Rs.38054 ha^{-1}) with 2.87 B:C ratio. This income was higher by Rs.12290 ha^{-1} over conventional tillage. The highest fertility level (100% RDF) also recorded the maximum seed (17.59 q ha^{-1}) and stover yield (41.40 q ha^{-1}) HI (41.9%), income upto Rs.37166 ha^{-1} and 2.88 B:C ratio. The income was higher by Rs.11752 ha^{-1} over control. The higher productivity of the crop was higher due to higher yield-attributes (pods/plant and pod length) under these treatments. These results corroborate with those of Omandi *et al.* (2014) and Singh (2018).

Table 2: Economics and seed quality of clusterbean as influenced by tillage practices and fertility levels (Mean of 2 years)

Treatments	Net income (Rs ha^{-1})	B:C ratio	Net income (Rs ha^{-1}) Difference over control	Seed protein (%)	Protein yield (kg ha^{-1})	Gum content in seed (%)	Gum yield (kg ha^{-1})
Tillage practices							
Conventional (3 cultivation)	26590	2.27	-	30.63	472.4	28.66	473.68
Minimum (1 cultivation)	32060	2.60	6296	31.24	501.8	29.59	510.97
Conv.+ 3 t ha^{-1} wheat residue	32433	2.63	6669	31.44	510.7	29.32	507.14
Mini.+ 3 t ha^{-1} wheat residue	38054	2.87	12290	32.00	516.3	29.97	540.05
C.D. (P=0.05)	3719	NS	-	0.81	18.5	NS	20.6
Fertility levels							
Control	26914	2.39	-	30.78	471.1	28.88	473.09
50% RDF ($N_{10}P_{20}K_{10}$)	31637	2.51	5223	31.23	499.5	29.36	511.83
75% RDF ($N_{15}P_{30}K_{15}$)	32583	2.59	6169	31.45	508.6	29.59	536.70
100% RDF ($N_{20}P_{40}K_{20}$)	37166	2.88	11752	31.84	522.1	29.95	521.47
CD (P=0.05)	2467	NS	-	0.95	19.17	NS	16.9

Con. = Conventional; Mini. = Minimum; NS = Non significant; Sig. = Significant

Grain quality

The CT or MT with WR enhanced the seed protein significantly (31.44-32.0%) and protein yield (510.7-516.3 kg ha^{-1}) over CT. This may be attributed to significant role of minimum tillage with wheat residue in regulating enhanced photosynthesis, root enlargement and better chemical and microbial activities under favourable soil conditions. Similarly 75 and 100% RDF increased both these parameters significantly over control. This might be attributed to most favourable soil conditions providing better nutrition to plants allowing more synthesis of protein through amino acids as a result of N-metabolsim (Saket, *et al.,* 2014). There was no any change in the gum content in seed, but gum yield was enhanced significantly (540 kg ha^{-1}) due to MT + WT as well as under increased supply of NPK (521.47 to 536.70 kg ha^{-1}) This might be due to increase in grain yield. These findings are consonance with those of Ayub *et al.* (2012) and Khumhar *et al.* (2013).

It may be concluded from the results that the minimum tillage having one cultivation plus 3 t ha^{-1} wheat residue along with 100% recorded the highest grain yield, quality and economical gain from clusterbean var. HG 563.

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