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Improved Pulse Production Technology - A Strategic Tool for Doubling Farmer's Income: A Review

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ABSTRACT

In Indian scenario, pulses are usually cultivated based on traditional experience acquired from our ancestors. Inflation in demand for pulses can't be met out with existing production practices resulting deficit in availability of pulses. To cater this domestically promotion of easily adoptable low cost production strategies needs wider attention aiming to improve pulse productivity in the country. This review discusses the capacity of various improved pulse production practices in scaling up pulse productivity and on other hand provides future prospects for sustaining pulse production with a prime aim to double the farmer's income.

Key words: Crop productivity, Improved pulse production, Nutritional security, Sustainable production.

Pulses constitute an important component of human diet across the world. Pulses are widely recognized as a rich source of protein and for its role in nitrogen economy by virtue of its nature to fix atmospheric nitrogen. Although, India ranks first in area and production of pulses in world with 29.45 M.ha. and 23.13 Mt (Anonymous, 2018) but due to stagnation in production over the years, net availability of pulses tumble from 60.7 g in 1951 to 43 g/day/capita in 2016 as against ICMR which recommends 65 g/day/capita (Tiwari and Shivhare, 2017). This witnessed volatility in prices of pulses in India might be due to widening of gap between the demand and supply of pulses. Since crop productivity is low in India compared with other developed countries raising concerns on enhancing productivity of pulses to meet protein mal nutrition in the country.

Further, this led to surge in imports to the tune of 2-4 million tonnes every year for meeting the demand of expanding population paving a way towards economic uncertainty in the country since domestic production is not commensurate with demand. To alleviate this demand a deliberate attempt to chalk out an efficient strategy that rescues the long term prospects of nutritional security, without compromising the sustainability in pulse production. Thus, with a hope to scale up productivity of pulses and highlight future concerns of research this attempt has been made to introspect various improved pulse production technologies with a prime objective of doubling farmer's income.

Tillage management

Tillage is a process of mechanical manipulation of soil with tools and implements for obtaining conditions ideal for seed germination, seedling establishment and growth of the crops. The long term objective of tillage is to provide a structure favourable for establishment of proper seed soil contact (Slipher, 1932).Tillage methods affects the sustainable resources through its influence on soil properties and crop growth (Banjara *et al.* 2017). Energy has become costly and profound, to tackle this efficiently conservation tillage method has been developed as an alternative (Kuzucu and Dokmen, 2015). Improved conservation tillage practice like zero tillage showed increase in organic matter with increase in time and reverse is true with respect to deep tillage. This improvement in soil properties over a long run contributes towards higher productivity of the crop. This is in confirmation with the results (Alam *et al.* 2014).

Selection of a variety

Vegetative and reproductive growth of crop are influenced by many factors among them selection of right variety which is adaptable to given set of environments is one of the important aspect which play an major role in achieving good crop growth and development.

Various varieties have been developed for improved yield, short duration, synchronous maturity, disease and pest resistance etc. that are adaptable to various agro-climatic and soil conditions. Proper selection through evaluation of most adaptable variety would be a key to improve pulse production. PU-35 variety of black gram found to be significantly superior in terms of grain and straw yield over other cultivars under investigation under sandy loam textured soil at Baraut, U.P. (Panotra *et al.* 2016). Similarly, in green gram, SML-668 variety performed better in both

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rainy and summer season over other varieties (Dodwadiaya and Sharma 2012).

Sowing time

Optimum **s**owing time synchronize to optimum climatic conditions required for attaining different phenological stages providing more time for growth and development of plant which is favourable for higher yield (Gurung *et al.* 1996). Sowing time is a non-monetary input, influencing growth and yield of the crop. The proper vegetative growth at satisfactory temperatures promotes efficient utilization of solar energy contributing to proper grain filling (Wani *et al.* 2018). Delayed planting restricts vegetative growth, reproductive branches and expedite the process of maturity. Confirming this, crop sown during 3rd week of November reported maximum yield while significant reduction in yield components of chickpea was observed with successive delay in sowing time (Kumar *et al.* 2018). Similarly, the delay in sowing of black gram beyond 30th June reduced the grain and stover yield but the yield from 30th June and 15th July sown crop are at par with each other, while further delay resulted in significant reduction in yield of the crop (Singh and Kumar, 2014). In pigeon pea, sowing time showed significant decrease in yield per unit area when sown beyond 15th May an ideal sowing to fetch maximum returns (Hariram *et al.* 2011).

Crop geometry

Crop geometry is considered a major factor determining the degree of competition between plants and maximum yield is obtained where competition between the plants is low.Optimum spacing requirement depends on crop type, variety, growing season and planting system. Too low and high plant population adversely affects the crop yields (Melak Agajie, 2018). Plants grown at closer spacing favours self thinning of branches and reported taller plants, while at wider spacing all the growth and yield components per plant observed to be superior due to better competitive advantage of crop favouring better nutrient absorption (Tungoe *et al*. 2018). However, black gram grown under clay loam soil observed to record significantly higher yield with 30×10 cm spacing over 45×10 cm (Murade *et al*. 2014) due to incompetent compensation of yield by wider spacing over more number of plants per unit area, comparatively. In contrast to this higher seed yield, stalk yield and biological yield in pigeon pea was obtained at 120×15 cm over closer row spacing 60 cm and 90 cm, respectively (Alse *et al.* 2017).

Sowing method

Method of sowing has direct effect on seed requirement, plant establishment , cultural operations and efficiency of production inputs. Around 25-30% of seeds and fertilizers were saved by following raised bed system of planting (Kumar *et al.* 2012). An increasing trend in favour of raised bed was recorded over flat bed sown green gram might be due to increased availability of nutrients, better crop establishment, improved weed management, enhanced input use efficiency and less soil compaction (Hariram *et al.* 2018). Chickpea showed maximum improvement in seed yield when raised on 75 cm raised bed followed by 67.5 cm raised bed over flat bed method due to increase in height of the bed might have contributed to enhanced nodulation, several growth and yield attributing characters (Kumar *et al.* 2015). While pigeon pea recorded significantly higher seed yield with sole transplanting over direct seeding (Sujatha and Babalad, 2018). Thus, application of appropriate sowing methods also determines productivity of crops when it is suitable to that eco-region (Choudhary and Suri, 2014).

Nutrient management

The application of nutrients in the easily available forms in sufficient amount to fulfil the needs of a particular crop holds the key for successful crop production. Fertilizer is an important input to boost the crop yields. It is most essential that right amount of fertilizers when applied at the proper time and proper place through an appropriate method improving nutrient use for enhancing crop productivity (Aulakh and Benbi, 2008). Combined application of RDF+Vermi-compost @5t/ha+rhizobium culture+PSB + trichoderma found to be better than increasing the dose of RDF in chickpea (Kumar *et al.* 2018). Biological nitrogen fixation in pulses made them less responsive to nitrogenous fertilizers. Rhizobium-legume association constitutes most of the biological nitrogen fixation and application of 5 kg sodium molybdate + 40 kg sulphur in association with rhizobium enhanced the rhizobium activity resulted in highest grain and stover yield (Satyapal *et al.* 2019). While phosphorus is the major limiting nutrient and key element involved in growth and development of pulses. Phosphorus plays a major role in stimulating root development which increases number of root nodules, consequently increasing N2 fixation and also involved in metabolic processes which in turn contributes towards sink development (Yadav *et al.* 2017). Application of 60 kg/ha phosphorus helped in realizing higher yield in pigeon pea (Ade *et al.* 2018). The major constraint with phosphorus fertilizer is that most of the fertilizer applied is not benefiting to the plant, instead it is getting fixed in the soil. The only application of phosphorus @ 60kg/ha increased the grain yield by 19.7% while additional application of PSB significantly increased the grain yield by 26.25% over control plot (Kachava *et al.* 2018). In black calcareous soils fertilization with 40 or 60 kg K_2O with 10kg/ha Zn along with FYM 5t/ha reported higher yield components in green gram (Ranpariya *et al.* 2017). Among the methods of fertilizer application, foliar nutrition is recognized as an important method since, it involves application of suitable concentrations of fertilizer directly to plant foliage. Foliar feeding of micro-nutrients like boron and molybdenum when applied in addition to RDF found to improve the green gram yield by 38% and black gram yield by 50% (Bhattacharya *et al.* 2004). The quality of lentil especially maximum protein content, albumin, essential amino acids like lysine, tryptophan and methionine have

been found to increase with the application of sulphur and zinc @ 30kg/ha (Chauhan and Mishra, 2018).

Water management

Increase in demand for irrigation water coupled with depletion in ground water resources made efficient use of water imperative. Although pulses are low water requiring crops but are responsive to irrigations. It is time to adopt an alternate strategy for improving irrigation water economy thus, expanding our scope to use our existing water resources smartly. This can be achieved only when the irrigation is applied on the real need basis of the crop. Extension in vegetative period even after flowering due to excess moisture might led to 10% higher yield with sprinkler irrigation at 100% pan evaporation surface irrigation method in black gram (Kumar *et al.* 2018). In clay loam soil drip irrigation recorded highest grain yield coupled with saving total water use over surface irrigation system (Solanki *et al.* 2019).

Weed management

Pulses have smothering habit hence management of weeds is matter of concern only during their initial stage of establishment. Timely weed control is very essential for realization yield potential in pulses. This period varies from crop to crop especially in chickpea weed free period from five leaf to full flowering (24-48 DAE) found to have significant influence on the grain yield of the crop. (Mohammadi *et al.* 2005). In blackgram crop grown in a weedy situation throughout crop period reported 40.1% reduction in grain yield while weed free upto 30-40 DAS was at par in terms of grain yield with weed free throughout the season (Kumar and Tewari, 2004).Investigation carried out in pigeon pea shows that broad spectrum weeds can be suppressed efficiently with the application of 16.5% sodium acifluorofen + 8% cladinofop propargyl @ 1kg/ha followed by Imazethapyr @ 0.05kg/ha as post emergence aiming to get maximum profit (Barla *et al.* 2018).Grassy weeds and dominant broad leaf weeds in green gram were reported to be significantly controlled by the application Imazethapyr+Imazimos 70% WG @ 100g/ha as a post emergence herbicide at 30 DAS reflecting in significant increase in yield of the crop (Deshmukh *et al.* 2018). Similarly, Pre-emergence application of pendimethalin 30 EC + Post emergence application Imazethapyr 2EC @ 1kg a.i. per ha + one hand weeding at 25-30 DAS found to reduce weed population and weed dry mass more efficiently followed by producing maximum yield in green gram (Kumar *et al.* 2019). Economic analysis of weed management practices in black gram revealed that highest net returns and B: C ratio was obtained from post emergence application of Imazethapyr + Imazemox @ 50g/ha at 20DAS followed by Imazethapyr + Pendimethalin @ 1000g/ha at 20 DAS (Mansoori *et al.* 2015).

Plant protection

Pulses are sensitive to many diseases and pests. Yield reductions are very prominent with both pest and disease infestations. Adoption of IPM and IDM is a strategy to protect the plants. In pigeon pea and chickpea it was found that use of novel insecticides along with advisories were effective against pod borers (Sharma *et al.* 2015). Bihar hairy caterpillar (*Spilosoma obliqua*) infestation is blooming in recent days leading towards heavier losses in black gram production. Triazophos 40 EC @ 40 g a.i./ha found to be 90.64% effective in controlling the hairy caterpillar below its ETL level (Mandal *et al.* 2013). Yellow vein mosaic virus transmitted by whiteflies is found to cause serious economic losses in many pulse crops by reducing the yield and quality of the crops and considered to be a major bottle neck in the production of black gram. This could be managed efficiently by seed treatment of imidacloprid and two sprays of imidacloprid 17.8 SL resulting higher growth and seed yield compared to other treatments (Archana *et al.* 2018).

CONCLUSION

This paper clearly highlighted various improved agricultural practices and their role aiming to improve the productivity of pulses in India. Since, expanding population limited our scope to bring non traditional area under pulse cultivation, so at this moment aiming at higher productivity would be an ideal way to provide nutritional security thereby limiting protein malnutrition in the country. Adoption of improved pulse production practices *viz*. zero tillage, optimum sowing time, raised bed planting method, foliar nutrition, INM, smart irrigation systems, IWM etc. would act as a perception changer highlighting future research priorities to tackle production vulnerabilities aiming at doubling farmer's income.

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