research in the Central Zone (CZ). The work plan was formulated for each research team through participatory approach.

Crop improvement team recommended to revise the sowing time under irrigated timely sown (from 10–20 to 1–15 November) and late sown (15–25 to 10–25 December) trials in North West Plains Zone (NWPZ). Yield limit for acceptance of trials in North Hills Zone (NHZ) under rainfed and late sown restricted irrigation was raised by 5 q/ha from the existing level. Targeted breeding programme for developing new genotypes responsive to higher inputs and conservation agriculture practices and developing genotypes with long coleoptiles for deeper seeding to enhance anchorage and lodging tolerance was also a part of the recommendation.

Resource management group recommended adopting zero tillage for better income since yield levels in zero and conventional tillage were almost the same. To improve the nitrogen use efficiency, urea top dressing should be done just before irrigation, which also gives higher productivity; application of Green Seeker technology will improve the efficiency further. Relay cropping of wheat in cotton should be adopted for higher productivity and profitability under cotton–wheat system in which seeding of wheat can be done by broadcasting dry or sprouted seed just after irrigation or zero till drilling by removing alternate rows of cotton using 25–50% higher seed rate.

Crop protection group recommended multiple disease/insect pest-resistant genotypes, contribution of entries in national genetic stock nursery and reconstitution of wheat disease monitoring nursery for research. The group recommended that susceptible varieties should be sprayed with propiconazole @ 0.1% to contain yellow rust at the time of initiation of symptoms, Fipronil 5 SC @ 125 g/ha mixed in 80 kg sand as broadcasting at crown root stage followed by irrigation for termite control, and foliar sprays of Metarhizium anisopliae @ 3 g/litre of water and *Beauveria bassiana* @ 5 g/litre or biocontrol of foliar aphids in wheat.

Wheat quality team recommended strengthening linkages with the industry, involving interested bakers/millers in research planning and product development, improving wheat quality for different products, developing varieties suitable for biscuits and incorporating nutritional quality traits in breeding programmes.

Barley network recommended 60 kg(N)/ha under rainfed conditions in NHZ (2/3 as basal and 1/3 after first rain/snowfall); application of Pinoxaden @ 40 g/ha + carfentrazone @ 20 g/ha or Pinoxaden @ 40 g/ha followed by metsulfuron @ 4 g/ha for weed control in NWPZ; application of Pinoxaden @ 40 g/ha + metsulfuron @ 4 g/ha or Isoproturon @ 750 g + metsulfuron @ 4 g/ha for weed control in NHZ; residue retention @ 6 tonne/ha to enhance productivity and quality under rice–barley cropping system; broadcasting of overnight-soaked and shade-dried barley seed @ 150 kg/ha for relay cropping in cotton and sown during 18 November–2 December under cotton–barley cropping system to enhance the quality and productivity of barley as well as of cotton.

Social sciences emphasized on timely release of funds to carry out the FLDs and monitoring, and agreed to conduct demonstrations on the use of 'hydrogel' at Karnal centre in the context of producing more crop per drop.

The varietal identification committee considered a total of nine proposals (eight wheat and one barley) and gave the following recommendations: In wheat, HD3171 and K1317 were recommended for rainfed timely sowing in NEPZ; HI8759(d) for irrigated timely sowing in CZ; MACS3949(d) and HI1605 for rainfed and irrigated timely sowing in PZ; PBW723 for irrigated timely sowing in NWPZ. The decision on WB2 and HPBW02 for irrigated timely sowing in all zones was kept pending subject to resubmission considering zone-wise superiority in yield and zinc. In barley, DWRB123 for irrigated timely sowing in NWPZ.

Finally, based on the deliberations and discussions during various technical sessions, as well as recommendations given under each session, the plan of research for the ensuing *rabi* season 2016–17 was finalized.

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MEETING REPORT

Pomegranate fruit cracking in dryland farming*

In India, livelihood security of 70% of the farming community is dependent on success or failure of crops in drylands. Pomegranate is one of the most suitable horticultural crops that promises sustainable livelihood security in these regions due to its very high return on investment (ROI), and good performance in dryland areas with very low requirement of irrigation. Pomegranate fruits are in great demand in the domestic as well as export market. Further, the fruit has tremendous potential for value addition due to its total utilization as food and pharmaceutical ingredient. A modest estimate of ROI in pomegranate ranges from Rs 2.00 to Rs 10.00 lakhs/ha as net profit against Rs 1.00–2.00 lakhs/ha from traditional crops in dryland farming.

Arid and semi-arid regions occupy almost 53.4% of India's land area, where rainfall is erratic and often comes in a few heavy spells of short duration resulting in high run-off, instead of replenishing the groundwater. In the dry ecosystem, climatic variability results in the regressive pedogenic processes which modify the physical, chemical and biological

*A report on the one day workshop on 'Fruit Cracking and Soil Health Management' held at the ICAR-National Research Centre on Pomegranate, Solapur on 3 October 2015. The workshop was held in collaboration with the Society for Advancement of Research on Pomegranate, Solapur.

properties of soils, resulting in poor crop performance. The dry, semi-arid region is characterized by nutrient-deficient sandy soils low organic matter. The region witnesses high wind velocity coupled with high evaporation rate, high temperature and solar radiation. The effective cropping season is restricted both by the quantity and distribution of rainfall, thereby setting limits on the choice of crops, cultivars and cropping system. Due to its inherent xerophytic nature, pomegranate is a favourite choice for fruit cultivation in these marginal lands. The fruit is drawing attention worldwide, because of its multipurpose nutraceutical and pharmaceutical utility due to which it has been categorized as 'superfruit' in the global functional food industry. Owing to its excellent keeping quality and remunerative prices in the domestic as well as export market, the area under pomegranate cultivation is increasing at a rapid pace in the dryland tracts of India.

Fruit cracking in pomegranate in dry semi-arid regions – a physiological disorder is a serious problem for sustainable economic productivity of the fruit. The cracked fruit, though sweeter, loses keeping quality and becomes unfit for shipment and undergoes rapid rotting. The economic loss due to fruit cracking ranges from 10% to 40%, sometimes going up to 70%.

Cracking in pomegranate occurs due to boron deficiency in young fruits. Heavy rain or irrigation after a dry spell causes moisture imbalance in the soil that aggravates cracking of the mature fruits. Similarly, over-maturity, disease and pest infestation, increased N, and imbalance between K and Ca also lead to fruit cracking. In the recently held national workshop on fruit cracking in pomegranate, N. K. Krishna Kumar (ICAR) took stock of the situation and planned a future strategy for management of the same. Deliberations on the causes of fruit cracking, its management strategies and relationship with soil health were also held in the workshop. Krishna Kumar emphasized the need for research to explore the mechanisms behind fruit cracking and its management through advanced studies like gene silencing, etc.

The growth and development of pomegranate follows a single sigmoid curve with growth, rind development and aril (edible part) development phases. The rind and aril development phases are critical for cracking and any adverse condition may cause cracking, sooner or later. There are studies on the relationship between fruit cracking and expression of the expansin gene. During growth, plant cells secrete a protein called expansin, which unlocks the network of cell-wall polysaccharides, permitting turgor-driven cell enlargement. Expansin weakens the non-covalent binding between wall polysaccharides which results in cracking.

However, the actual mechanism of fruit cracking is not yet fully explored. There is an urgent need to pinpoint the mechanisms and factors involved in the process so as to formulate various management practices for control of fruit cracking. Possible management options include individual fruit wrapping using LLDPE stretch film, fruit bagging, hormonal sprays, chemical and nutrient spray, soil moisture conservation, application of anti-transpirants, etc.

Optimum leaf nutrient status in pomegranate has been worked out using multivariate compositional nutrient diagnostics for identifying nutrient imbalance in the plant. With regard to soil health management, it was concluded that a lot of work needs to be undertaken in areas prone to fruit cracking in order to understand the role of soil health influencing cracking in pomegranate. Hence, it is important to initiate fundamental research on soil health management and pomegranate cultivation for sustainable livelihood security in dryland farming system.

In the plenary session on 'Fruit cracking and soil health management', an action plan was chalked out to bring out a status report on fruit cracking and initiate research taking into consideration all the influencing factors, viz. weather condition, soil moisture regime, plant nutrition, biochemical and molecular studies and cultural practices for sustainable productivity in pomegranate. While the ICAR-National Research Centre on Pomegranate (NRCP), Solapur, along with ICAR-Indian Institute of Horticultural Research, Bengaluru would conduct basic studies under controlled environment, the ICAR-Central Institute for Arid-Horticulture, Bikaner, and its regional Centre at Godhra, and All India Coordinated Research Project on Arid Zone Fruits (AICRP on AZF) centres and agricultural universities of Gujarat and Rajasthan, would conduct experiments to validate the hypothesis derived from basic studies. The five-year study is expected to reveal the mechanism of fruit cracking and ascertain the involvement of various factors. ICAR-NRCP has identified a cracking-resistant wild rootstock IC-318712 for pomegranate and standardized the grafting technique to utilize the rootstock to combat the menace of cracking. This rootstock has been vegetatively propagated following sanitation protocol and distributed to four research centres involved in the AICRP on Arid Zone Fruits for further evaluation.

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