# Nilgiri Wheat News

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### A high yielding semi-dwarf *dicoccum* wheat Nilgiri Khapli (HW 1098) released for cultivation in *dicoccum* growing areas of India


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In India, dicooucm - which is popularly known as Samba, Jave, Sadaka or Khapli is produced roughly closer to 10 million tonnes. The entire *dicoccum* is produced from the states of Maharashtra, Karnataka, Gujrat and parts of Tamil Nadu and Andhra Pradesh. In the last one decade, there was significant area and production increase for *dicoccum.* The increased market demand can be attributed to factors such as public awareness on the role played by *dicoccum* as health food and *dicoccum* based food products have easy digestibility, low glycaemic value and it has been considered as a therapeutic food in the management of diabetes. Over the last one decade several of semi-dwarf *dicoccum* wheat varieties were released for cultivation to replace the traditional and tall Indian *dicoccum* varieties like NP 200 and NP 201 (released during late 1960's). But many of these semi dwarf varieties do not have the actual grain quality as that of the NP 200 or NP 201, which can be attributed to the fact that the dwarfing genes were derived from durum wheat, which has strong linkage drag for quality traits. Since the market demand for *dicoccum* is very high, both the farmers and millers are looking for such variety with high yield potential with better end use quality. Hence an attempt was made at IARI, Regional Station, Wellington with aim to develop a semi-dwarf wheat variety with high yield potential and matching grain quality as that of traditional tall varieties employing gama irradiation technique which resulted in developing the variety HW 1098 (Nilgiri Khapli). It has been now been released for cultivation considering its performance in the all India co-ordinated yield trials.

#### The salient features of the variety HW 1098

The variety HW 1098 has yielded significantly superior over *dicoccum* and *aestivum* checks viz., DDK 1009, MACS 2971, (*dic*), MACS 2496 (a*estivum*) throughout the testing period and recorded highest zonal mean grain yield of 45.53q/ha and recorded overall yield advantage of +14.9% over DDK 1009, +8.3% over MACS 2971 and +5.9% over MACS 2496. Over the three years of testing across the zones it occurred 23/30 times in first non-significant group as compared to best *dicoccum* check var. MACS 2971 indicating wider adaptability and stability in performance across zones. It has consistently out yielded over the *dicoccum* checks, both under normal time of sowing & late sowing conditions with overall mean yield of 40.47q/ha and 32.73q/ha respectively in the agronomy trial,which are significant and it recorded lesser yield loss in late sown conditions when compared to checks.

The variety HW 1098 has shown high degree of seedling and adult plant resistance, particularly for leaf and stem rust. The recommended zone is acting as secondary foci for multiplication and further spread of leaf and stem rust (migratory route in *Puccinia* path). Cultivation of HW 1098 dicoccum variety along with durums and aestivums

in a mosaic pattern will curtail further spread of rusts.

The variety HW 1098 produced bold, lustrous grain having 46.5g grain weight, comparable level of protein (16.8%), sedimentation value (29.0ml) and Beta carotene (3.39ppm) as that of traditional variety NP 200, coupled with higher yield potential and disease resistance. Thus the cultivation of 'Nilgiri Khapli' will be remunerative to the farmers because of its consistent yield performance (mean grain yield of 45.53q/ha) and will help in sustaining the livelihood of the farmers in the recommended areas. This variety will act as an additional genetic barrier against the spread of brown and black rust in the migratory path ( *Puccinia* path) because of its high degree of rust resistance and it will increase the genetic diversity in the *dicoccum* cultivating zone.

**High yielding bread wheat culture HW 5207 carrying pyramided rust resistance genes proposed for state release of Tamil Nadu as COW 3**

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the advance culture HW 5207 is a high yielding bread wheat variety suitable for southern hill zone and adjoining areas in Tamil Nadu under restricted irrigation. It is a limited backcross derivative of HW 3029// V763-2312 (Yr*15*) with a duration of 95-100 days. Frequent failure of monsoon resulting in shortage of irrigation water led to decline in productivity of winter crops in hilly and their adjoining areas in Tamil Nadu. This situation forced farmers to adopt alternative crop with short duration, less water requirement and free from pest and diseases. In this situation, the advance wheat culture HW 5207 could be an alternative option to the farmers in 14 districts of Tamil Nadu *viz*., Nilgiris, Coimbatore, Tirupur, Erode, Dindugul, Theni, Salem, Karur, Namakkal, Dharmapuri, Krishnagiri, Vellore, Thiruvannamalai and Villupuram.

HW 5207 has recorded the highest mean grain yield (4076 kg/ha) which is 12 per cent increase over the check COW (W) 1 (3641 kg/ha) in a total of 131 trials. It has the ideal plant height (90 cm) with erect plant type, strong and resilient stem providing resistance to lodging. It produces very nutritious grains, registering a mean test weight of 40.5g with more than 11 percent protein, and high level of Iron (53.1ppm), Zinc (46.3ppm), Copper (5.33ppm) and Manganese (47.5ppm) indicating excellent grain nutritional quality. In addition, this variety has high scores for bread making quality (7.0 out of 10), *chapathi* quality (7.4 out of 10) with Glu-1 score of 8 out 10 and mean sedimentation value of 45.5 ml, high Hectolitre weight of 78.3.

It exhibited high degree of resistance to stem, leaf and stripe rusts under both artificial and natural epiphytotics against all the pathotypes occurring in the Nilgiris which is a hot spot for rust incidence. The resistance to rusts and powdery mildew is attributed to the presence of the combination of genes *viz*., *Sr*2 and *Sr*24 for stem rust, *Lr*24 for leaf rust and *Yr*15 for yellow rust derived from the parents involved in the cross. Presence of these genes has also been confirmed through molecular markers. Due to high and stable yield performance over locations and resistance to leaf and stem rust diseases, the culture, HW 5207 is proposed for release as "Bread Wheat COW3" for the benefit of farmers as the best alternative winter crop.

**HW 3601 (INGR 13051) and HW 3631 (INGR 13052), wheat lines with resistance to stem and leaf rust diseases registered as genetic stocks in NBPGR**

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The stem and leaf rusts of wheat respectively caused by *Puccinia graminis* Pers. f.sp. *tritici* Eriks. & E. Henn. (*Pgt*) and *P. triticina* Eriks. (*Pt*) are of countrywide importance in India. Both the diseases survive and spread from the source of their primary inocula available all-the-year-around in Nilgiri / Palni hills of South Hill Zone and Himalayas of North Hill Zone (Nagarajan and Joshi, 1985). From epidemiological point of view, the Pgt urediospore dispersal in India is unidirectional from the southern hills only (Nagarajan *et al*. 2006). On the other hand, primary inoculum of *Pt* originates both from Nilgiri/Palni hills and Nepal Himalayas, establish initial disease foci respectively in Peninsular/Central India and adjoining Himalayan tarai areas and spread further to other parts of the country (Nagarajan and Joshi, 1985).

Central zone (CZ) is the migratory route of stem and leaf rust urediospores originating from Nilgiri/Palni hills. Rust inocula disseminate through CZ with the help of wind systems as defined in Indian Stem rust rules to main wheat growing areas in Northern plains of India (Nagarajan and Joshi, 1985). Rust inoculum built up on any susceptible variety in CZ will be of serious threat to the wheat crop in the Indian wheat bowl of NWPZ. Hence, the development and release of rust resistant high yielding wheat varieties and their cultivation in CZ is the envisaged strategy of wheat rust control which rests on diversifying the genetic basis of rust resistance for curtailing build up of rust inoculum in CZ.

Keeping in mind the objective of rust free production of wheat in CZ and to check the northwards spread of leaf and stem rust inoculum originating from south Indian hills, stem rust (*Sr*) and leaf rust (*Lr*) resistant genetic stocks were developed at Indian Agricultural Research Institute, Regional Station, Wellington-643 231, The Nilgiris, Tamil Nadu, by the introgression of two independent segments of linked genes, *Sr*25/*Lr*19 (from *Agropyron elongatum*) and *Sr*36/*Pm*6 (from *Triticum timopheevii*) into the genetic background of high yielding, well adapted and rust susceptible wheat cultivars, C306 and WH147 of CZ.

Australian line, Cook*6/C 80-1, carrying stem/leaf rust resistance genes, *Sr*25/*Lr*19 and *Sr*36/*Pm6* used as donor parent and rust susceptible well adapted cultivars, C306 and WH147 were used as recurrent/recipient parents. Three cycles of back crossing were performed and final constitution made at $BC_3$-$F_5$ generation. Evaluation of the $BC_3$-$F_5$ lines along with their recurrent parents and controls carrying specific *Sr* and *Lr* genes under natural and artificial conditions indicated that the newly constituted lines confer resistance to most of the leaf and stem rust pathotypes at seedling (Table 1) and adult plant stages. Presence of *Sr*25/*Lr*19 and *Sr*36/*Pm6* were validated by applying the SCAR markers SCS 265, SCS 253 and Gb for *Lr*19 and SSR marker Stm 773 for *Sr*36 (Sivasamy *et al*. 2009).

Thus the newly constituted lines would serve as donor for leaf and stem rust resistance genes and the availability of combination of major and genetically diverse resistance genes in well adapted wheat cultivars would facilitate the strategic deployment to achieve enhanced resistance.

Table 1. Seedling reactions of parents and genetic stocks to selected pathotypes of stem and leaf rusts

| Sl. No. | Parents/Genetic stocks | Reaction to pathotypes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Stem rust | | | Leaf rust | | | | |
| | | 40A | 40-1 | 117-6 | 12-3 | 77-5 | 77-7 | 77-8 | 104-2 |
| 1 | Cook*6/C 80-1 | ; 1 | ; 1 | ; 1 | ; 1+ | 0 ; | ; 1 | 3C | ; |
| 2 | C 306 | 4 | 4 | 4 | 3+ | 3+ | 2C | 3C | 3+ |
| 3 | HW 3601 | ; 1 | ; 1 | ; 1 | ; 1 | ; 1 | ; | 3 | ; 1 |
| 4 | WH 147 | 4 | 4 | 4 | 3+ | 3+ | 3+ | 3+ | 3+ |
| 5 | HW 3631 | ; 1 | ; 1 | ; 1 | ; 1 | ; 1 | ; 1 | 3+ | ; 1 |

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**Status of rust resistance genes in wheat cultivars of central and peninsular India**


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Primary inoculum of stem and leaf rusts of wheat grown in peninsular and central India commences from Nilgiri hills where weather permits obligatory survival of pathogen all over the year. This nonstop host – pathogen collectiveness ensues pathogenic mutations fostering new rust virulences which ruin the resistance of existing cultivars in peninsular and central India. Appraisal of resistance genes hitherto protecting cultivars from Nilgiri borne inoculum is one of the prime objectives of IARI, Regional station, Wellington situated in Nilgiri hills. An analysis on effectiveness of rust resistance genes present in cultivars of central and peninsular India

to the existing rust flora in Nilgiris is presented here in respect of five years surveillance and race analysis of stem and leaf rusts. Genes commonly deployed in peninsular and central India are *Lr*1, *Lr*3, *Lr*10, *Lr*13, *Lr*14a, *Lr*24 and *Lr*26 in case of leaf rust and *Sr*5, *Sr*9b, *Sr*9e, *Sr*11 and *Sr*24 in case of stem rust. Strength of resistance imparted by these genes was assessed by percentage of avirulent field isolates on the respective stocks. Only *Lr*24 for leaf rust and *Sr*31 for stem rust showed complete resistance while all others were susceptible to one or more pathotypes. Though varieties possessing *Lr*24 and *Sr*31 grow rust free in central and peninsular India yet these are under threat in case Ug99 gains access to India. Genes *Sr*2, *Sr*22, *Sr*27, *Sr*29, *Sr*32,*Sr*33, *Sr*35, *Sr*36, *Sr*39, *Sr*40 etc. for stem rust and *Lr* 9, *Lr*19,*Lr*24, *Lr*25, *Lr*28, *Lr*32 etc. for leaf rust show promise if used as pyramids in permutation and combinations.

**Can 7DL.7Ag translocation become a substitute for 1BL.1RS translocation in spring wheat ?**

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The 1BL.1RS translocation in spring wheat is one of the most significant translocation because of its role in enhancing the grain yield coupled with resistance genes for the rusts and powdery mildew. Similarly, the 7DL.7Ag translocation from *Agropyron elongatum* that carries leaf rust (*Lr*19) and stem rust (*Sr*25) resistance genes appears to be a promising gene not only for rust resistance, but also for yield enhancement. Near isogenic lines carrying *Lr*19/*Sr*25 gene developed in ten genetic backgrounds were tested for 2 years with and without fungicide treatment. The *Lr*19/*Sr*25 gene significantly increased the grain yield under rust free condition (with fungicide treatment) (7-11%) and rust infected conditions (without fungicide treatment) (34 - 47%) and other yield attributing traits such as number of tillers/plant, spike length, number of grains/spike, biomass/plant, grain yield/plant, 1000 grain weight and harvest index than the recurrent parent, along with low rust reaction. Yield enhancement was highest in the genetic backgrounds where both the translocations (7DL.7Ag and1BL.1RS) were present, indicating a synergistic interaction. Moreover, presence of 7DL.7Ag translocation caused delayed heading and maturity by 7-10 days and 7-12 days respectively in rust free conditions. Yield enhancement in rust infected conditions could be partly by the gene against rusts and partly by the gene action on yield, while in rust free condition it could be directly attributed to the gene action. Quality traits viz., test weight, grain hardness, sedimentation value and protein content, either improved or remained same as the recurrent parent and had no negative effect in rust free condition and increased under rust infected conditions. Invariably, yellow pigment content remained higher than the recurrent parents, but within the permissible limit under both the conditions. Genetic background of the recurrent parent can affect the utility of the translocation, since wide range of variation was observed among the traits.

**Effective alien rust resistance gene *Lr*45-derived from *Secale cereale* pyramided with *Triticum timopheevii*-derived stem rust resistance gene *Sr*36 in the back ground of Indian bread wheat cultivars**

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The effective leaf rust resistance gene *Lr45* present in RL 6144 stock-derived from *Secale cereale* through T2AS-2R# 3S.2R#3L translocation, conferring high degree of resistance against occurring leaf rust pathotypes in India. This gene *Lr45* was taken for introgression into nearly 30 popular and adapted Indian released wheat cultivars at Indian Agricultural Research Institute, Regional Station, Wellington. The stable lines carrying *Lr45* was constituted at BC3F5 stage which were conferring high degree of field resistance under natural epiphytotic conditions at Wellington, which is a 'hot spot' for leaf and stem rusts in India and these were further crossed with a stock HW 4444-carrying *Triticum timopheevii*- derived linked stem rust gene *Sr36+Pm6.* The resistant lines pyramided with *Lr45* and *Sr36+Pm6* were picked at BC3F5 stage based on adult plant response to leaf, stem rusts and powdery mildew under natural epiphytotic conditions. The combination of Lr45, Sr36+Pm6 showed immune rust reaction to all the occurring leaf and stem rust pathotypes which include 17, 77A, 77-5, 77-7, 77-8, 77-10, 40A and 40-1 and scored 0-2 scale for powdery mildew on 0-9 scale.

Similarly when the SRT test was carried out with afore mentioned races in the glass house the seedling response for both leaf and stem rust ranged from 0 to ; confirming the transfer of these genes. From our observations *Lr45* is linked to a phenotypical marker 'pinked awn' which get well expressed at dough stage when the night temperatures are below 15$^{o}$C.

**Wheat Front Line Demonstration in Southern Hill Zone during 2012-13**

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The FLDs for the year 2012-13 were conducted with newly released wheat varieties like COW (W) 1, COW 2 and HW 5216 covering an area of 20 ha. Trials were allotted to Vellore, Dharmapuri, Tirupurl, Nilgiris, distiricts of Tamil Nadu and Mandya of Karnataka. For the first time, the FLDs were monitored by a separate monitoring team consisting of scientists from IARI, RS Wellington, DWR Karnal and a representative from Ministry of Agriculture. The monitoring team participated in the Field Day organised at Kadamadai village, Pennagaram,Dharmapuri district along with the local SMS from KVKs of Papparapatty. The other Field Day was organised at the Nadumottur village, Vellore district along with the ATMA unit members of that region. Following were the observations recorded during the overall monitoring of wheat FLDs and Field Days conducted by the Wellington
This year again 20 FLDs have been allotted. The demonstrations will be planted at Vellore, Dharmapuri, Udumulpet, Nilgiris and Coimbatore. The wheat varieties such as COW2, HW 5216 and HW1098 will be included.

**News**

Dr. Jagdish Kumar, Head & PS has been selected for the position of Head of IARI Regional Station for cereals and temperate fruits, Shimla (Tutikandi and Amartara Cottage).

Dr. M. Sivasamy, Principal Scientist has been given the charge of acting Head, IARI, Regional Station, Wellington.

Sh Vinod Chandra, Assistant has been transferred to IARI, KVK, Shikohpur.

Sh. Bijender Kumar (LDC), joined station on 2nd December, 2013.

Sh. Arvind (T-1) joined station in November, 2013.